

Contents

1	Introduction	1
1.1	Glare in Road Traffic	1
1.2	Motivation and Task Definition	4
2	Theoretical Background	7
2.1	Light Perception	7
2.1.1	Characteristics of Light	7
2.1.2	The Human Eye	10
2.1.3	Brightness Adaptation	14
2.2	Contrast Perception	17
2.3	Difference Disability Glare - Discomfort Glare	19
2.4	Photometric Terms	24
2.4.1	Luminous Flux	24
2.4.2	Luminosity	25
2.4.3	Luminance	25
2.4.4	Illuminance	26
2.5	Display Hardware	26
2.5.1	Liquid Crystal Displays	27
2.5.2	Digital Light Processing	29
2.5.3	Liquid Crystal on Silicon	30
2.5.4	High Dynamic Range	31
3	Related Work	33
3.1	Two different Approaches	33
3.1.1	Glare Effects Simulated in Hardware	33
3.1.2	Glare Effects Simulated in Software	35
3.1.3	Comparison	38
3.2	Computer Graphics	41
3.2.1	Tone Mapping	41

3.2.2	Rendering glare sources	43
3.3	Cognitive Psychology	45
3.3.1	Fully Adapted Contrast Perception	45
3.3.2	Impact of Glare	46
4	User Study: Varying the Glare Duration and Intensity	49
4.1	Preliminary Considerations and Expectations	49
4.1.1	Design of the TVI-Test	50
4.1.2	Test Cases	50
4.1.3	Glare Parameters	51
4.1.4	Avoidance Behavior	53
4.1.5	Simplifications	54
4.1.6	Glare Source	55
4.1.7	Expectations	56
4.2	Method	57
4.2.1	Test Design	57
4.2.2	Execution	59
4.3	Results	60
4.4	Discussion	66
5	User Study: Varying the Ambient Illumination	69
5.1	Theoretical Background and Expectations	69
5.1.1	Test Cases	70
5.1.2	Glare Parameters	70
5.1.3	Simplifications	71
5.1.4	Expectations	72
5.2	Method	72
5.2.1	Test Design	72
5.2.2	Execution	73
5.3	Results	74
5.4	Discussion	77
6	Field Test: Validating the User Study Measurements	81
6.1	Preliminary Considerations and Expectations	81
6.1.1	Simplifications	81
6.1.2	Parameters	82
6.1.3	Expectations	83

6.2	Method	83
6.2.1	Test Design	83
6.2.2	Execution	84
6.3	Results	85
6.4	Discussion	87
7	Modeling and Implementation	89
7.1	Modeling	89
7.1.1	Generalization of the Measured Values	89
7.1.2	Extrapolation	92
7.2	Implementation	93
7.2.1	Concept	93
7.2.2	Virtual Test Drive	94
7.2.3	VTD Post-Processing and Results	95
7.3	High Dynamic Range Displays	96
7.3.1	Display Control	96
8	User Study: Evaluating the Simulation	101
8.1	Preliminary Considerations and Expectations	101
8.1.1	Fundamental Questions	101
8.1.2	Conceptual Design	102
8.1.3	Glare Parameters	103
8.1.4	Simplifications	104
8.1.5	Expectations	105
8.2	Method	106
8.2.1	Test Design	106
8.2.2	Execution	107
8.3	Results	108
8.4	Discussion	110
9	Final Results and Discussion	113
9.1	Conclusion	113
9.2	Discussion and Future Work	115
	Bibliography	119