

Contents

List of Tables	iii
List of Figures	iv
Chapter 1 Introduction	01
1.1 Microscopy	01
1.2 Bright field microscopes	02
1.3 Two-beam quantitative phase microscopy	04
1.4 Self-referencing off axis DHIM using lateral shearing geometry	06
1.5 Two-lens wavefront division DHIM	08
1.6 Integration of low cost optical tweezers to self-referencing DHIM	09
1.7 Outline of the thesis	10
Chapter 2 Compact, low cost and field portable bright field microscope	11
2.1 Basics of brightfield microscopes	11
2.2 Single lens brightfield microscope	12
2.3 Development of compact field portable bright field microscope	13
2.4 Imaging with the compact bright field microscope	15
2.5 Image analysis	16
2.6 Elimination of background and identification of WBC	17
2.7 Identification of RBC	19
2.8 Identification of platelets	20
2.9 Image analysis of microscope with 50× magnification	21
2.10 Conclusions	22
Chapter 3 Off-axis digital holographic microscope for quantification of blood cells	24
3.1 Digital holography	26
3.2 Numerical reconstruction of 3D profile of objects	32
3.3 Digital holographic interference microscopy	34
3.4 Two-beam DHIM based on Mach-Zehnder interferometer (MZ-DHIM)	36
3.5 Three-dimensional imaging of red blood cells using MZ-DHIM	37
3.6 Label-free identification of malaria using MZ-DHIM	40
3.7 Device	50
3.8 Conclusions	51

Chapter 4	Compact field-portable off-axis self-referencing DHIM	52
4.1	Self-referencing DHIM – Concept	52
4.2	Lateral shearing self-referencing DHIM – Concept	53
4.3	Lateral shearing self-referencing DHIM – Laboratory unit (using CCD array)	56
4.4	Lateral shearing self-referencing DHIM – Portable unit (using webcam array)	60
4.5	Transforming bright field microscope to digital holographic microscope	69
4.6	Conclusions	73
Chapter 5	Two-lens wavefront division digital interference holographic microscopy	74
5.1	Two lens wavefront division digital holographic microscope (WD-DHM)	74
5.2	Microscope calibration	77
5.3	Spatial and temporal stability of the microscope	80
5.4	Quantitative 3D imaging of red blood cells	81
5.5	Imaging of thickness fluctuations in red blood cells	85
5.6	Portable Wavefront Division Digital Holographic Microscope	86
5.7	Conclusions	88
Chapter 6	Lateral Shearing Digital Holography Microscopy of Immobilized Cells	89
6.1	Optical Tweezers	90
6.2	Forces experienced by dielectric particle (Mie/Rayleigh regime)	92
6.3	Concept of Trap Stiffness and Corner frequency	94
6.4	Simulation of optically immobilized particle using OTGO toolbox	95
6.5	Development of Optical Tweezer using DVD drive pickup unit	96
6.6	Sample preparation	100
6.7	Trapping of polystyrene micro-spheres and red blood cells	100
6.8	Corner frequency and trap stiffness measurement for polystyrene beads	102
6.9	Integration of LS-DHIM to low-cost optical tweezer	105
6.10	Conclusions	109
Chapter 7	Future Scopes and road ahead	110
	References	113
	List of Publications	122