**TABLE OF CONTENTS**

**Page**

**TITLE PAGE** i

**APPROVAL SHEET** ii

**ABSTRACT** iii

**DEDICATION** iv

**ACKNOWLEDGEMENT** v

**TABLE OF CONTENTS** vi

**LIST OF FIGURES** xi

**LIST OF TABLES** xii

**CHAPTER 1: INTRODUCTION**  1

1.1 Background of the Study 1

1.2 Statement of the Problem 2

1.3 Objectives of the Study 3

1.4 Significance of the Study 3

1.5 Scope and Limitations 4

1.6 Definition of Terms 4

1.7 Theoretical Framework 9

1.7.1 Hardware 9

1.7.1.1 SoCKit Development Board 9

1.7.1.1.1 Cyclone V SoC 10

1.7.1.1.1.1 Dual-Core ARM Cortex-A9 12  
 MPCore Processor

1.7.1.1.2 USB 3300 Hi-Speed USB Host, 13  
 Device or OTG PHY

1.7.1.1.3 KSZ9021RL/RN Gigabit Ethernet 14  
 Transceiver

1.7.1.1.4 VGA 15

1.7.1.1.5 Memory 16

1.7.1.2 Logitech C525 Webcam 17

1.7.1.3 Micro SD Card 17

1.7.2 Software 18

1.7.2.1 In-System 18

1.7.2.1.1 Linux Kernel 18

1.7.2.1.2 Debian Operating System 18

1.7.2.1.3 OpenCV Library 19

1.7.2.1.4 Lightweight X11 Desktop 19  
 Environment (LXDE)

1.7.2.2 Development Software 20

1.7.2.2.1 Altera Quartus 20

1.7.2.2.2 Qsys - Altera’s System Integration Tool 20

1.7.2.2.3 SoC Embedded Design Suite 21

1.7.2.2.4 Linaro Toolchain 21

1.7.2.2.4.1 Linaro GCC 21

1.7.2.2.5 Github 22

1.7.2.2.6 Win32 Disk Imager 22

1.7.2.2.7 PuTTY 23

1.7.2.2.8 Others 23

**CHAPTER II: Review of Related Literature**  24

2.1 OpenCV 24

2.2.1 QpenCV Face Detection 24

2.2.2 OpenCV Face Recognition 26

2.2 Current State of OpenCV Acceleration. 27

2.2.1 OpenCV GPU 27

2.2.2 OpenCV IPP 28

2.2.3 OpenCV Applications with Zynq-7000 All 28  
 Programmable SoC

2.3 USB Video Class 29

**CHAPTER III: Methodology** 31

3.1 System Requirements 31

3.2 Top Level Face Detection System Design Overview 31

3.3 Hardware Preparation 32

3.4 Development Environment Preparation 33

3.5 Integration Layer 34

3.5.1 Golden Hardware Reference Design 34

3.6 OS Layer 34

3.6.1 Modified Linux Kernel Source 34

3.6.2 U-Boot Configuration 35

3.6.3 SD Card Image 36

3.6.3.1 The Debian Based Linaro Ubuntu Image 36

3.6.3.2 Partitioning of the SD Card Image 36

3.6.3.3 System Files 36

3.6.4 Utilities 37

3.6.5 OpenCV Library 37

**CHAPTER IV: Result and Discussions** 39

4.1 OpenCV Face Detection 39

4.2 System Bugs 39

4.2.1 USB UVC Bandwidth Issues with USB OTG 40

4.2.2 USB UVC has some issues FFMPEG 41

**CHAPTER V: Conclusion and Recommendation** 42

5.1 Conclusion 42

5.2 Recommendations 42

**BIBLIOGRAPHY** 44

**APPENDICES** 49

**Appendix A:** Expanded Block Diagram of the Face Detection System49

**Appendix B:** SoCKit Development Kits & Tools Detail50

**Appendix C:** ARM® Cortex™-A9 MPCore™ Specification52

**Appendix D:** FPGA Configuration Mode53

**Appendix E:** Configuring U-Boot56

**Appendix F:** From RocketBoards Org On How to Partition a uSD Card 57

**Appendix G:** Specs of the Intel CISC based system58

**Appendix H:** Kernel Panic Logs59

**Appendix I:** Researcher’s Notes on SoCKit Usage61

**Appendix J:** Face Detection System SoCKit Test Results65

**Appendix K:** Standard 512x512 pixels test image 66

**Appendix L:** Intel CISC Based Core i7 Test Results67

**Appendix M:** Source code used for performance comparison68

**CURRICULUM VITAE** 74

**LIST OF FIGURES**

**FIGURE PAGE**

Figure 1 System Block Diagram of the SoCKit Evaluation Board 10

Figure 2 Cyclone V SoC Integrated Circuit Block Diagram 11

Figure 3 Cortex A9 MPCore 12

Figure 4 Basic ULPI USB Device Block Diagram 14

Figure 5 Connections between Cyclone V SOC and FPGA and Ethernet 14

Figure 6 Functional Block Diagram of the KSZ9021RL/RN 15

Figure 7 VGA Block Diagram 16

Figure 8 Connections between FPGA and DDR3 17

Figure 9 Top Level block diagram of the Entire System. 31

Figure 10 Top Level System Overview 32

Figure 11 Development Tools 33

Figure 12 Boot Process 37

**LIST OF TABLES**

**TABLE PAGE**

Table 1 Comparrison of CISC based and Cyclon V SoC. 39