EEL4924C Electrical Engineering Design II

(Senior Design)

Final Design Report

PROJECT TITLE: Biometric Access Control System

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ABSTRACT

The goal of our project is to design and implement a biometric access control system that uses the fingerprint sensor to authenticate the user. Upon successful authentication, the user will be allowed entry and the update will be sent to the administrative console for auditing purpose. On the other hand, if the access is denied four times, at the 5th attempt the security breach buzzer will be activated to deter any potential theft.

The fingerprint sensor utilizes serial communication through the microprocessor using the UART ports. The system consist of fingerprint sensor, Atmel Atmega324P microprocessor, LCD Display, electronic door strike, LEDs, MAX232 serial level converter, FTDI serial to USB, Buzzer, and the PC terminal. Access events will be sent to the terminal for auditing purposes. The owner will be able to connect, Enroll, delete, delete all, and Get the fingerprint list.

Table of Contents

I. INTRODUCTION

The objective of designing the Biometric Access Control system is to strengthen the security while keeping the entry access user friendly. Furthermore, the user will NEVER have to worry about losing the keys, remembering the password, or losing the smart access card. All the authentication is performed by the access control system. This system can easily be interfaced in wide range of applications such as, door lock system, safe, simple access controller, vehicle control, and ATM. The Owner can keep track of access list simply through the PC. In addition, this system is interfaced with the security breach alarm that will deter any potential threats.

List of Tables & Figures

II. TECHNICAL OBJECTIVES

The technical objective of the design of this project is broken into three functional blocks that are as follows:

- Establish protocol communication between Fingerprint sensor and the microprocessor
  (Atmel ATMEGA 324P) using the UART0.
- Step down the voltage from 5V DC Voltage to 3.3V DC for the fingerprint sensor.
- Establish bidirectional communication between the microprocessor and the terminal through FTDI serial to USB converter by using the UART1 at the microprocessor end.
- Write backend terminal software to establish connectivity, Enter Master Mode, Enroll Users, Delete a user, Delete all users, and Get the fingerprint list.
- Design an embedded security breach alarm (analog design) to deter any theft.

Main Objective:

The main objective of this project was to design an access control system that will allow access to the audit console through the PC. In addition, interface an alarm system.

Features:

- Fingerprint sensor device (Nitgen FIM3040) ADSP-BF531 Blackfin based system is capable of gathering and storing finger prints via serial. The features are as follows:

  - Serial at 9600bps
  - 3.3V@200mA

- Capture in 0.2s
- Verification in 1.0s

- Atmel Atmega 324P microprocessor was the core of this design that controlled communication between the fingerprint device, terminal program, and the analog alarm circuit.

    - UART 0 was used to control the communication between the fingerprint sensor and the microprocessor.
    - UART1 was used to control the communication between microprocessor and the PC terminal.

Features

- High-performance, Low-power AVR® 8-bit Microcontroller
- High Endurance Non-volatile Memory segments

– 16/32/64K Bytes of In-System Self-programmable Flash program memory
– 512B/1K/2K Bytes EEPROM
– 1/2/4K Bytes Internal SRAM
– Write/Erase Cycles: 10,000 Flash/ 100,000 EEPROM
– Data retention: 20 years at 85°C/100 years at 25°C(1)
– Optional Boot Code Section with Independent Lock Bits
In-System Programming by On-chip Boot Program
True Read-While-Write Operation
– Programming Lock for Software Security

- Peripheral Features

– Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
– One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
– Real Time Counter with Separate Oscillator
– Six PWM Channels
– 8-channel, 10-bit ADC
Differential mode with selectable gain at 1x, 10x or 200x
– Byte-oriented Two-wire Serial Interface
– Two Programmable Serial USART
– Master/Slave SPI Serial Interface
– Programmable Watchdog Timer with Separate On-chip Oscillator
– On-chip Analog Comparator
– Interrupt and Wake-up on Pin Change

- I/O and Packages

– 32 Programmable I/O Lines
– 40-pin PDIP, 44-lead TQFP, 44-pad VQFN/QFN/MLF (ATmega164P/324P/644P)
– 44-pad DRQFN (ATmega164P)
– 49-ball VFBGA (ATmega164P/324P)

- Operating Voltages

– 1.8 - 5.5V for ATmega164P/324P/644PV
– 2.7 - 5.5V for ATmega164P/324P/644P

- Speed Grades

– ATmega164P/324P/644PV: 0 - 4MHz @ 1.8 - 5.5V, 0 - 10MHz @ 2.7 - 5.5V

- Analog alarm system was design using several OpAmps, 555 Timer, IRF510 N Channel MOSFETS, and audio Amplifier. This design was then interfaced with the microprocessor to control the mute function.

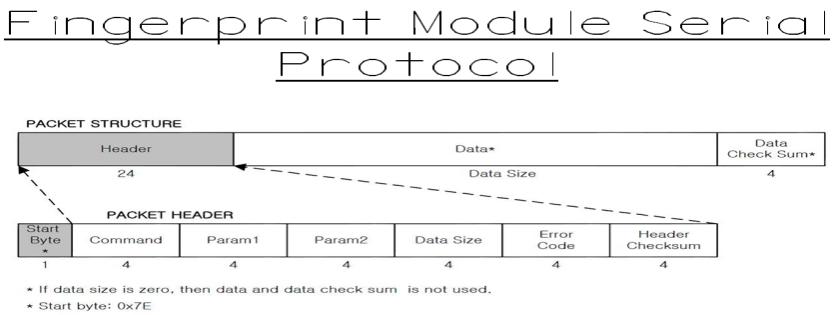
III. Concept/Technology

FingerPrint Sensor:

The fingerprint sensor (Nitgen FM3040) was used to designed the Biometric Access control system. This device was used to communicate with the Atmel Atmega 324P. Microprocessor

Figure 1

Fingerprint Sensor Packet Structure:



***NOTE * Header Checksum = Command + Param1 + Param2 + Data Size + Error Code**

Figure 2

Fingerprint Sensor and AVR Module:

Request Connection Command – Determines if you are connected to the FIM3040			
Command	0x01	**Command**	0x01
Parameter 1	X	**Parameter 1**	Result Succeeded
Parameter 2	X	**Parameter 2**	Fingerprint Count
Data Size	0	**Data Size**	0
Error Code	X	**Error Code**	Error Code
HDR Checksum	0x01	**HDR Checksum**	N / A

Figure 3

To check the communication between the fingerprint sensor and the AVR, command “packet” was sent to the fingerprint and then the AVR waited for the acknowledgement. Fingerprint sensor responded with the acknowlesgement “Result succeeded”. Hence, the communication between the fingerprint sensor and the AVR was established.

ATMEL Atmega 324P:

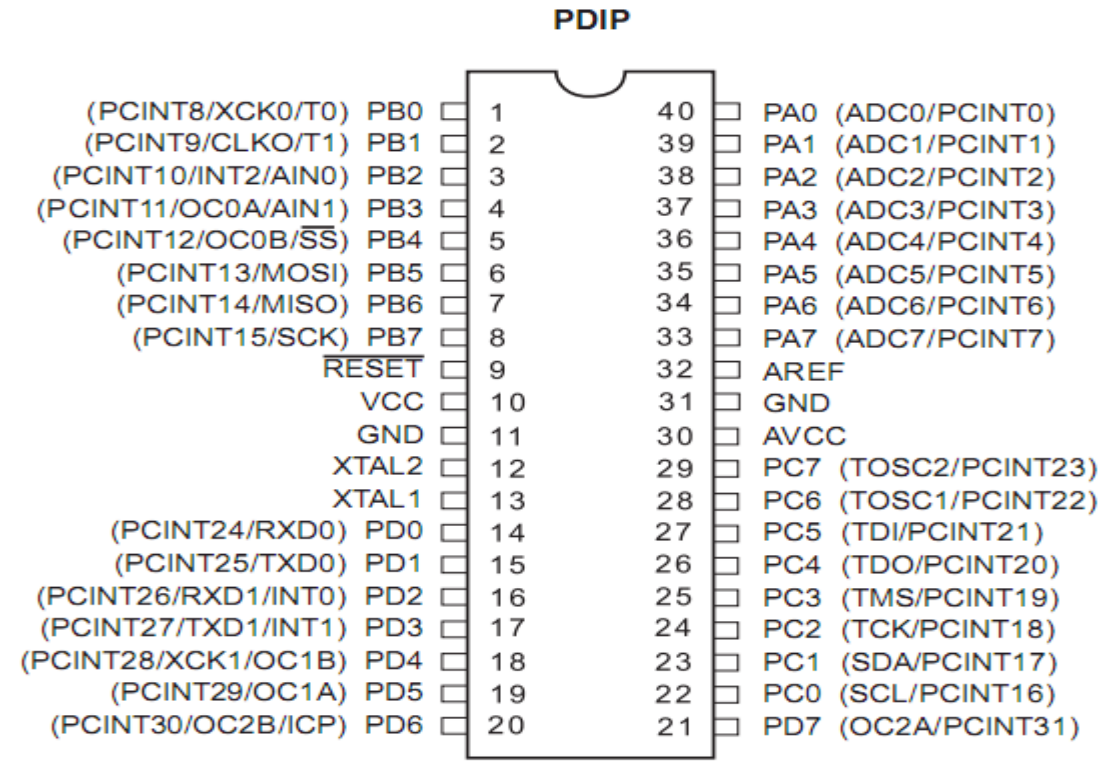


Figure 4

The ATMEL chip used in our design was chosen primarily because of the fact that it contains two UARTs which was used to established communication between the terminal and the fingerprint through the microprocessor.

Biometric Access Control Board layout:

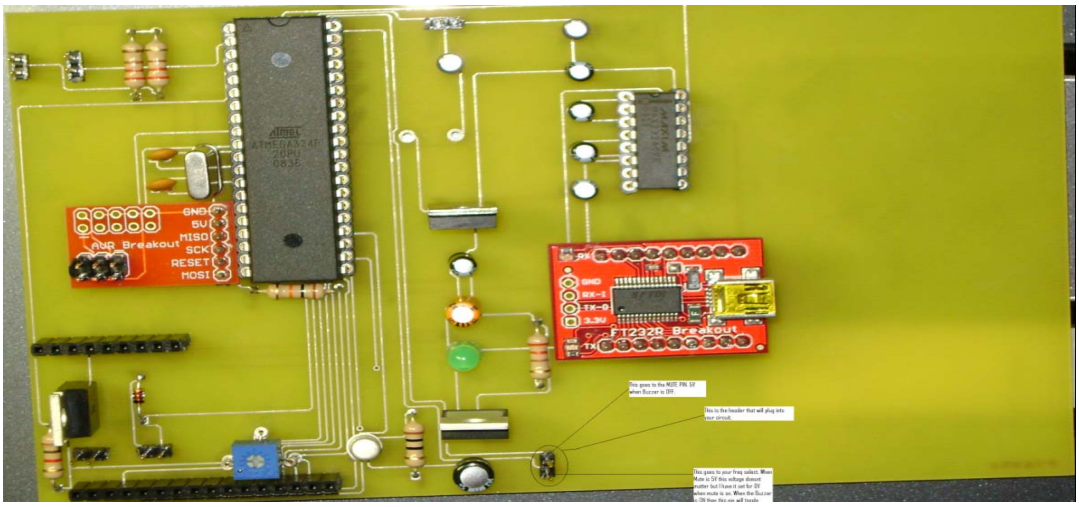


Figure 5

Analog Security Breach Alarm Board layout:

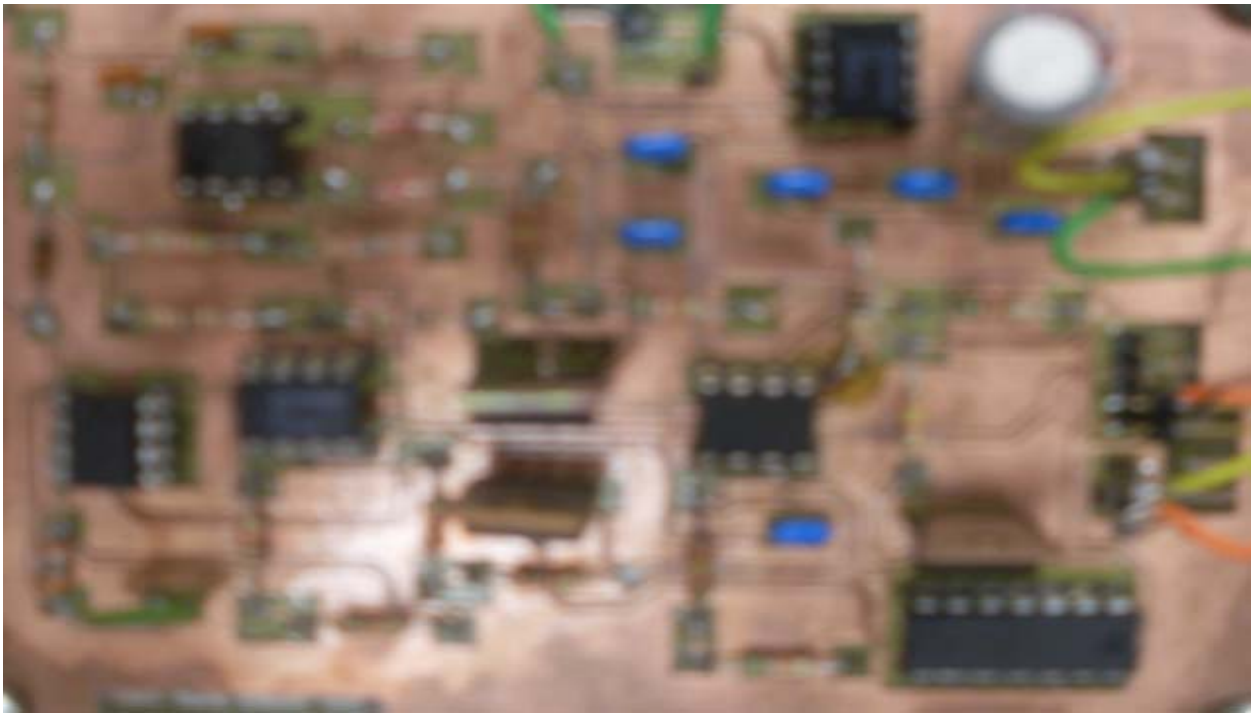


Figure 6

The output of the oscillator and the timer is as follows. Due the frequencies being the same at ~500HZ. It is difficult to differentiate the sound.

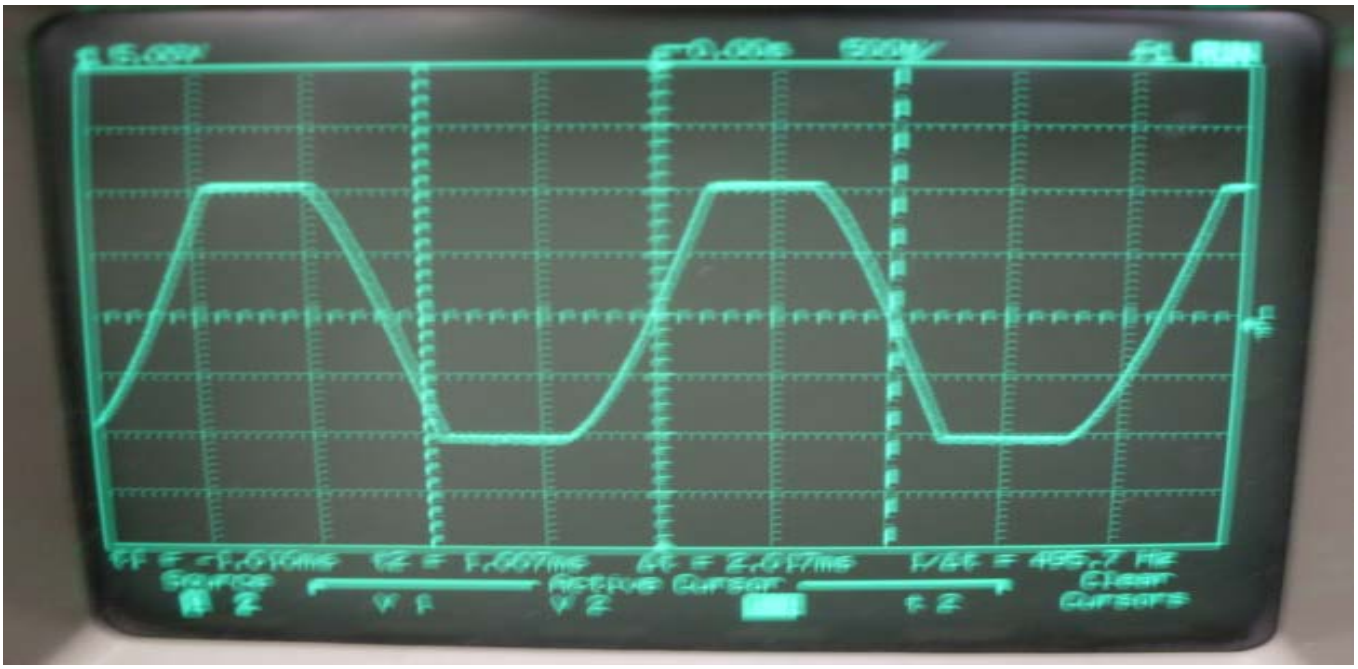


Figure 7 (Oscillator output)

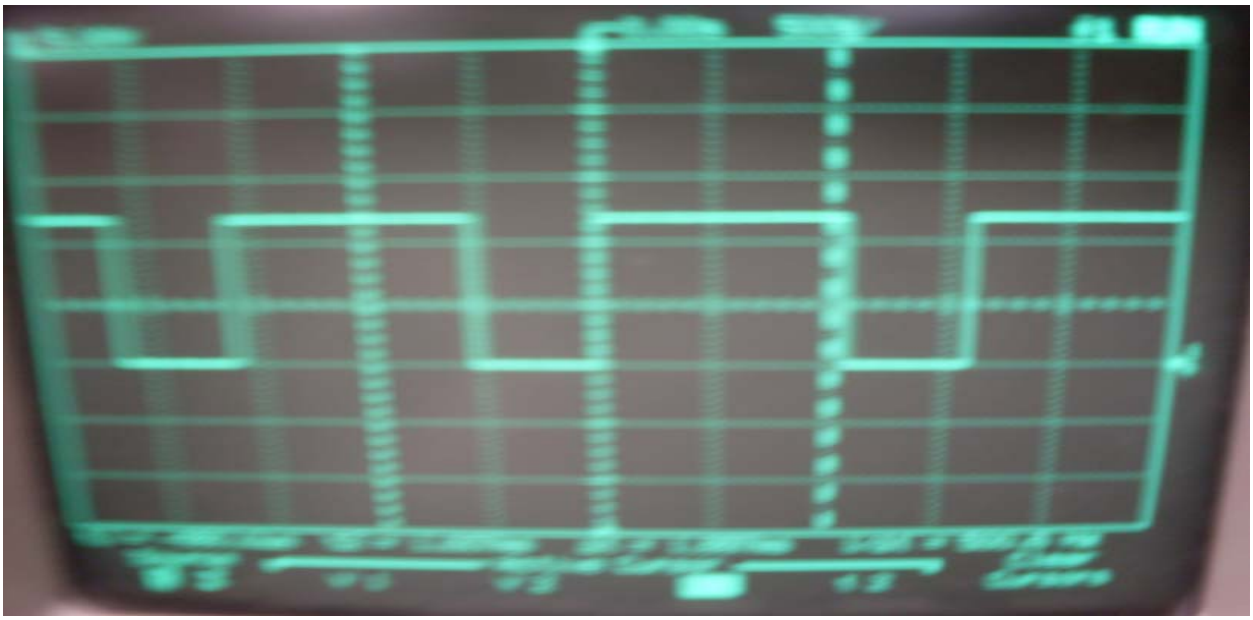


Figure 8 (NE555 Timer Output)

IV. System Architecture:

System architecture consist of the fingerprint module, FTDI serial to USB converter, PC Terminal, Atmel ATMEGA 324P microprocessor.

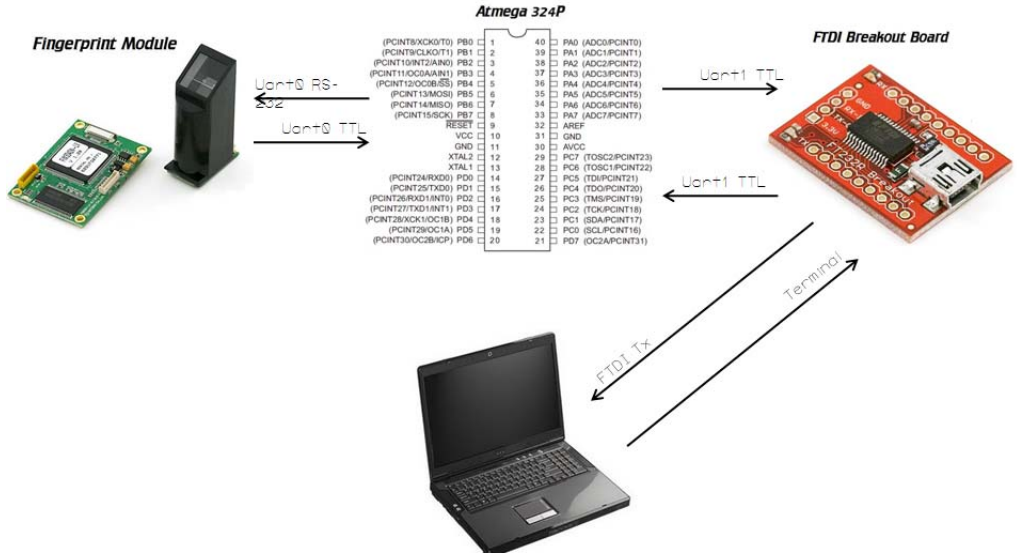


Figure 9 (System Architecter)

Fingerprint module to Microprocessor Block:

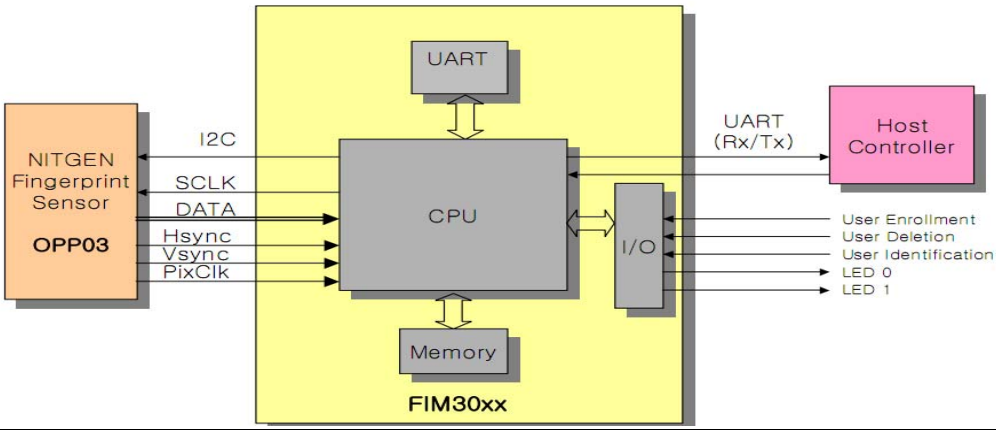


Figure 10

Block Design:

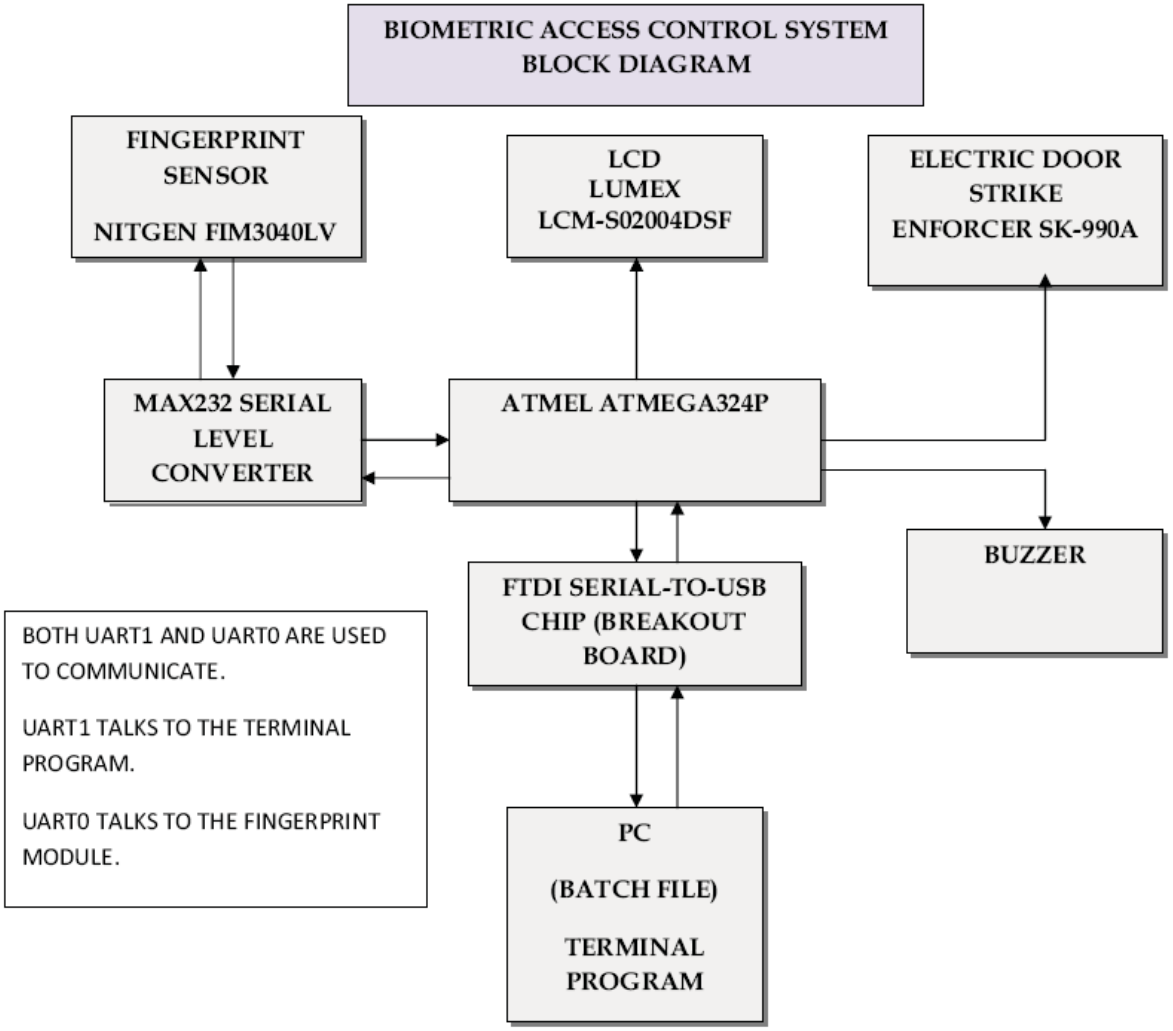


Figure 11

Alarm Block Diagram:

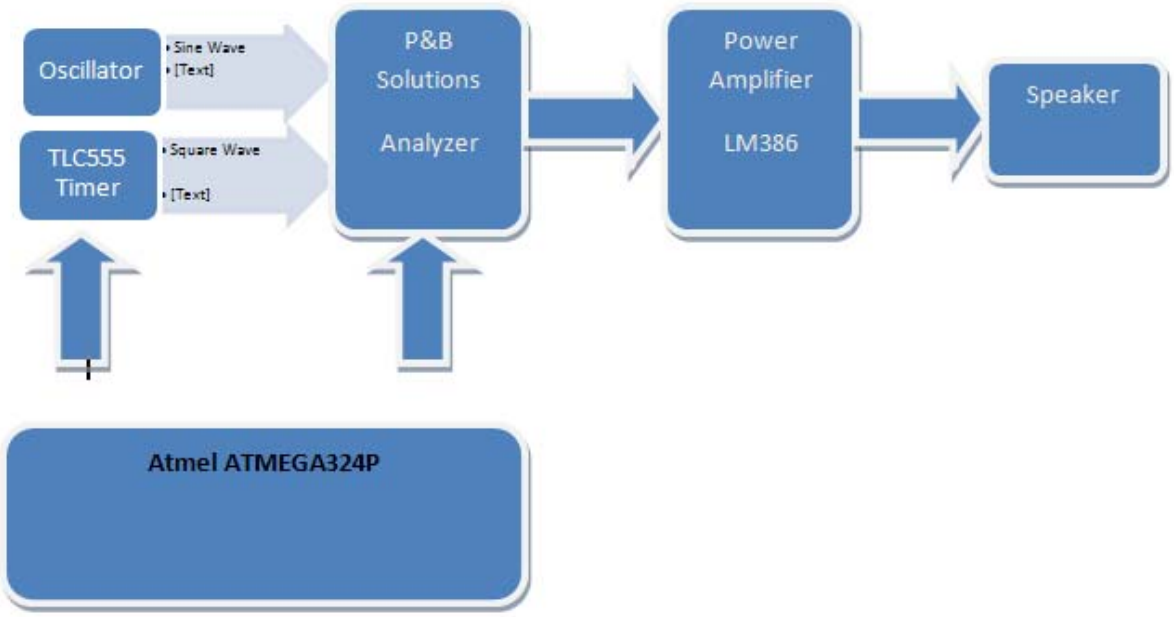


Figure 12

Digital Circuit Schematic:

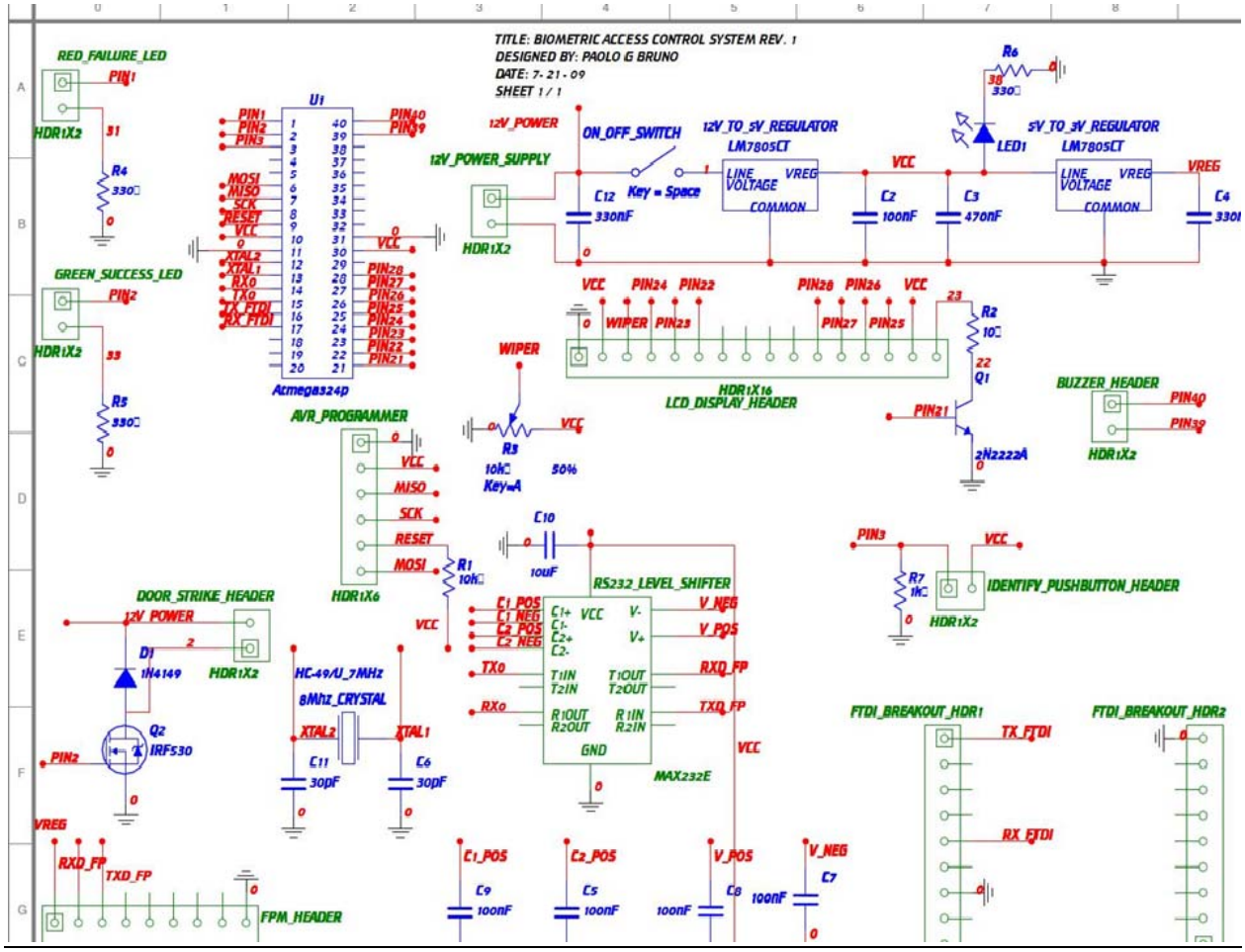


Figure 13

Analog Circuit Scematic:

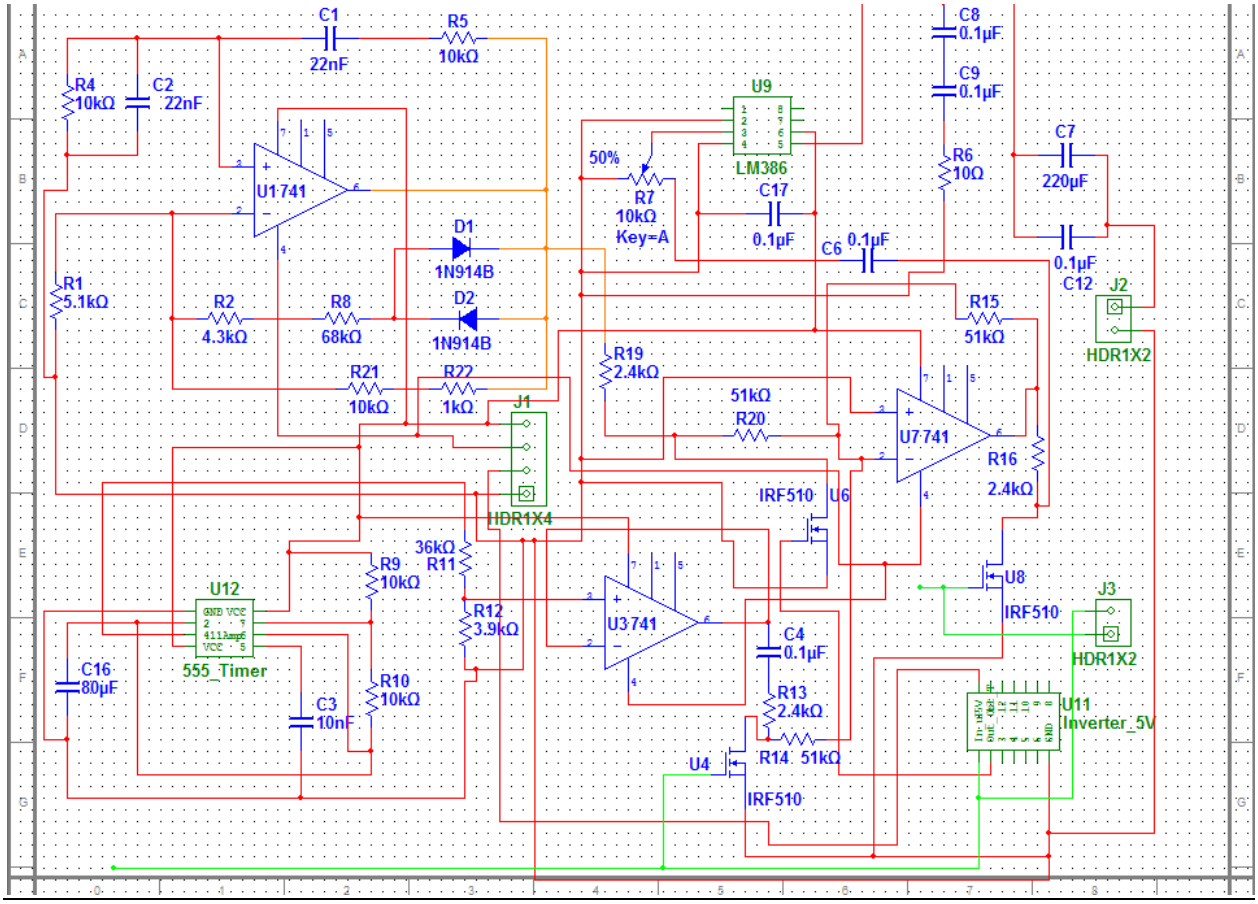


Figure 14

Analog PCB:

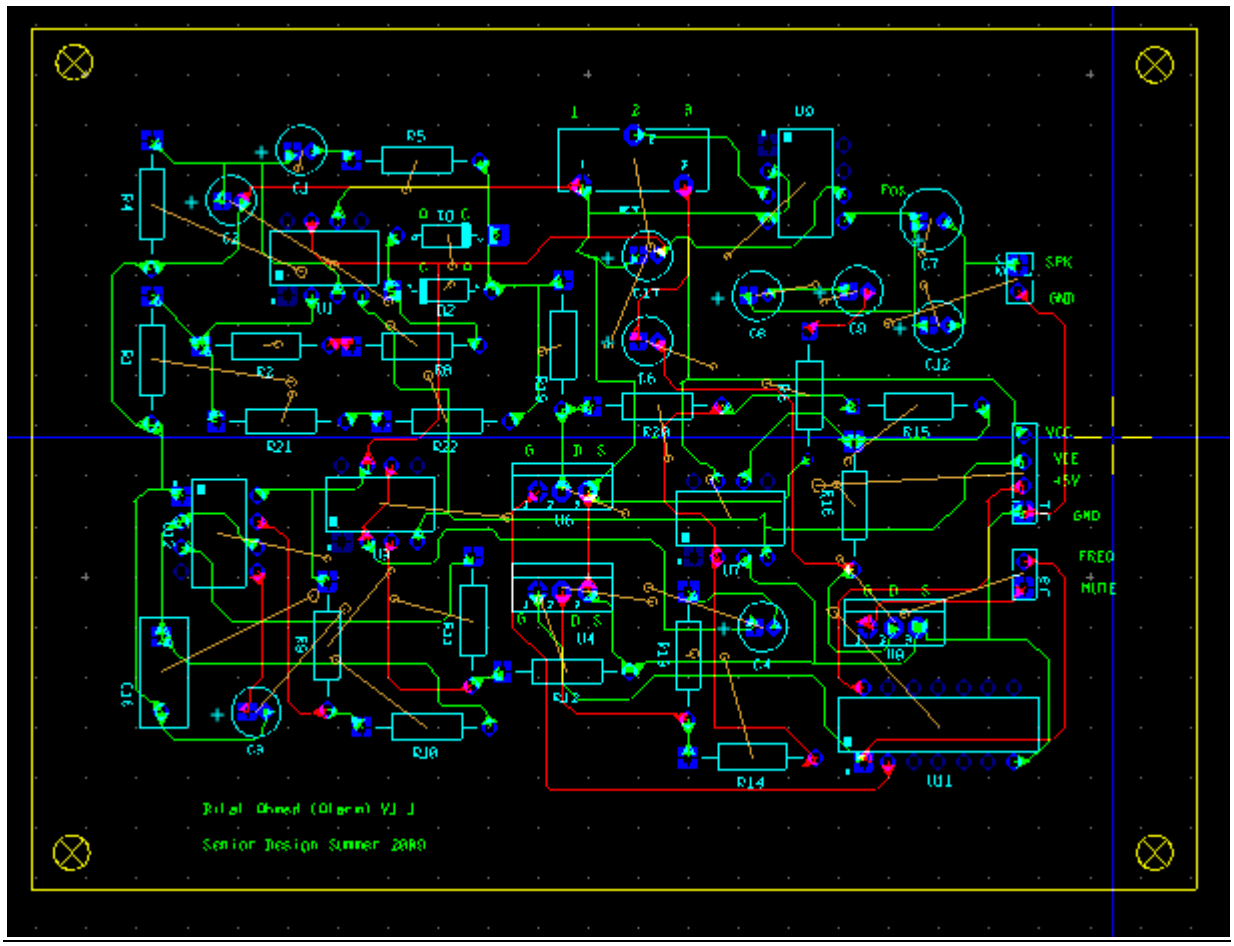


Figure 15

Software FlowChart:

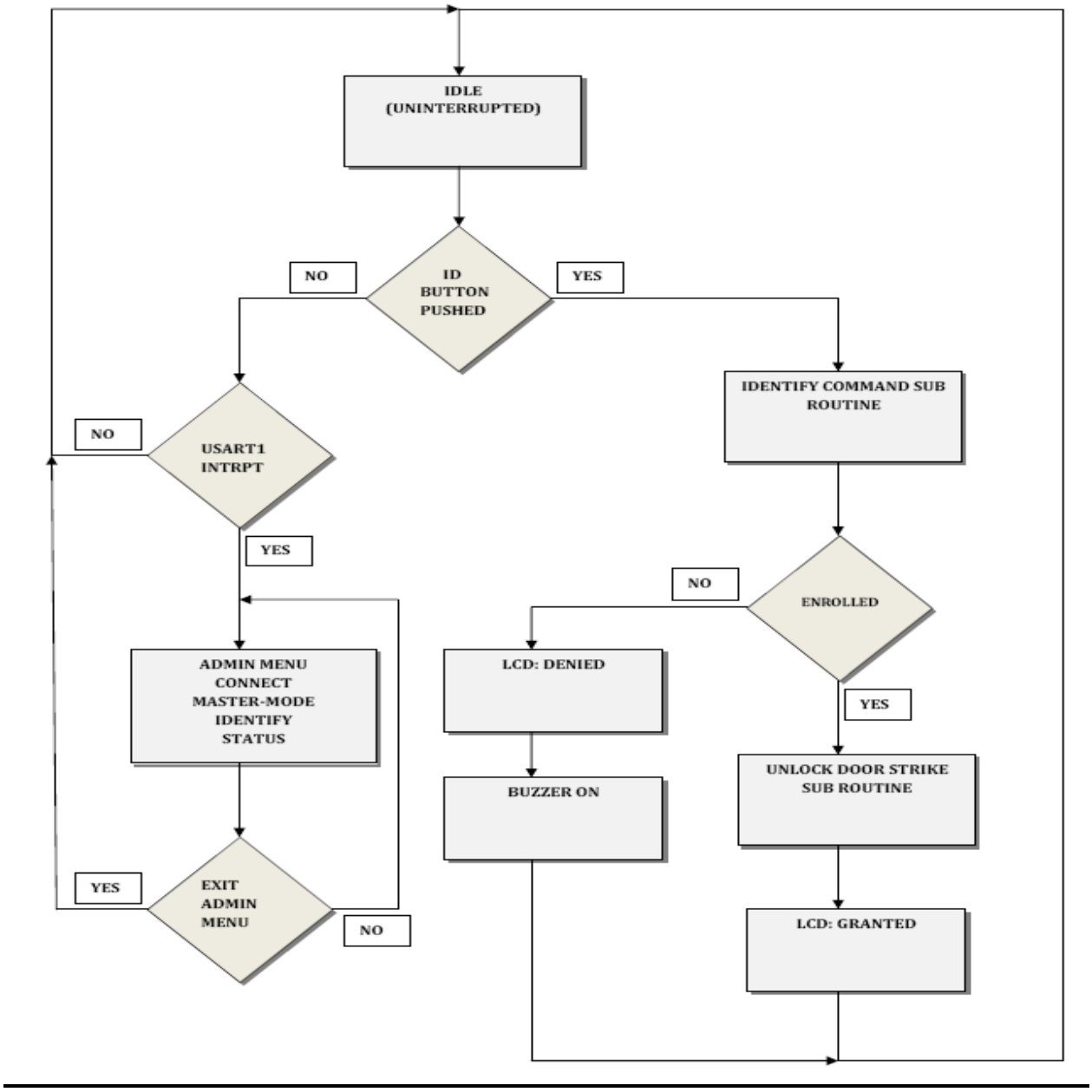


Figure 16

V.Division of Labor:

Task	Team Member
Preliminary Research:	
_ Fingerprint Sensor	**BA**
_ Microprocessor choice	**PB**
_ Electronic Door Strike	**BA**
Output Characteristics of fingerprint sensor	**PB,BA**
Fingerprint sensor/Atmel Integration	**PB**
Ordering Parts:	
_ Digital parts	**BA,PB**
_ Analog Parts	**BA**
Design Overview/layout:	
_ Digital Breadboarding	**PB**
_ Analog Breadboarding	**BA**
_ Digital PCB	**PB**
_ Analog PCB	**BA**
Coding:	
_ Hyperterminal	**PB**
_Visual Basic Front End Design	**BA**
_ Serial Communication using VB Script	**BA**
Debugging:	
_ Terminal code	**PB,BA**
Demonstration	**PB,BA**

V. USER MANUAL

Step 1: Connect to the PC via USB cable through the FTDI serial to USB converter.

Step2: Enter Master Mode

Step3: Enroll the user

Step4: Scan fingerprint

Step5: Door opens and access allowed

If the user is not enrolled and makes numerous attempts to access the access system, security breach alarm turns on.

VI. Bill of Material:

Parts/Components	Amount	Price per Unit	Total
Atmega 324P	1	$6.00	$6.00
Fingerprint Module	1	$135	$135
Door Strike	1	$30	$30
LCD	1	$8	$8
PCB (Digital)	1	$120	$120
PCB (Analog)	1	$33	$33
			$332

Table 2

The Competition:

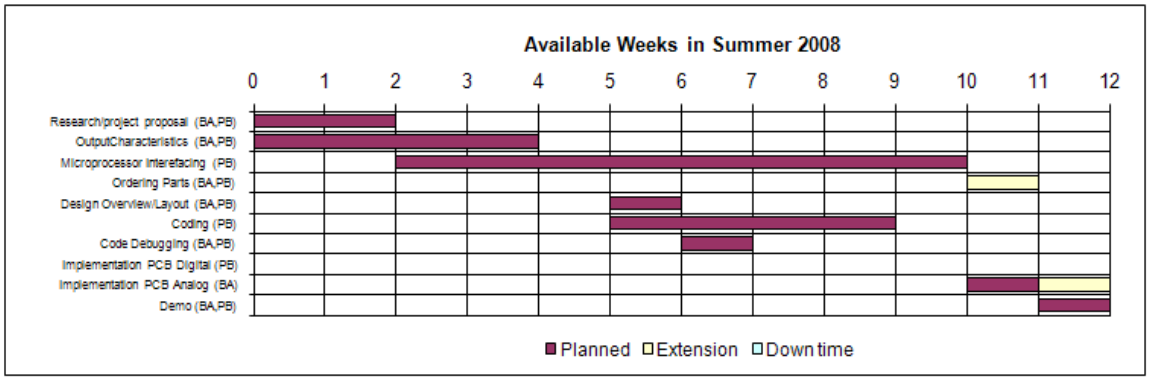
At Amazon.com Biovault Biometric safe is being sold for over $400. Our design integrates two additional features that our competition does have.

1) Auditing through the PC
2) Burglar Alarm

Figure17

VIII.Gantt Chart:

Task Name		Planned	Extension	Down time	
Research/project proposal (BA,PB)	0	2	0	0	2
OutputCharacteristics (BA,PB)	0	4	0	0	4
Microprocessor Interefacing (PB)	2	8	0	0	10
Ordering Parts (BA,PB)	10	0	1	0	11
Design Overview/Layout (BA,PB)	5	1	0	0	6
Coding (PB)	5	4	0	0	9
Code Debugging (BA,PB)	6	1	0	0	7
Implementation PCB Digital (PB)	7	0	0	0	7
Implementation PCB Analog (BA)	10	1	1	0	11
Demo (BA,PB)	11	1	0	0	12



IX.Final Product

Our final product is well designed with Color LCD, LEDs, Reset Push button, allows administration through the PC, and embedded alarm system.

Figure 18

IXX. Appendix:

http://www.amazon.com/Biovault-Biometric-Safe-Fingerprint-Reader/dp/B0016N5EH4

(Competition weblink)