EEL 4924 ELECTRICAL ENGINEERING DESIGN (SENIOR DESIGN)

FINAL REPORT

19 APRIL 2011

SMART PRESENTATION REMOTE

TEAM MEMBERS

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PROJECT ABSTRACT

The Smart Presentation Remote will be a remote control to enable those giving presentations using software packages such as Microsoft PowerPoint or OpenOffice.org Impress a novel method to control their presentations and have access to extra information while presenting in a handheld hardware package. The remote will feature the ability to advance back and forth through slides in a similar manner to commercially-available remotes allowing the presenter to easily set the pace of their presentation. It will also have an integrated MEMS gyroscope that will be used to control the mouse cursor, allowing the presenter to interact with the presentation without moving to a computer. The most important feature that will differentiate our product with other solutions is an LCD screen on the remote that gives the presenter information pertaining to time management, slide number, and additional notes pertaining to the current slide not visible to the audience.

The Smart Presentation Remote will be implemented with an Atmel AVR XMEGA microcontroller. This microcontroller will interface with an LCD screen, Bluetooth module, and gryoscope. The host computer will run software to communicate with the device over Bluetooth. The initial target host platform was Microsoft Windows 7 running Microsoft Office PowerPoint 2007/2010. Compatibility with OpenOffice.org Impress was also implemented. The device and host implement communications over a Bluetooth serial COM port to allow compatibility with a wide range of devices and ease of development for any future work.

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INTRODUCTION

Presentations made with Microsoft PowerPoint and similar programs have become an important part of modern life for virtually all cases in which information needs to be effectively conveyed to an audience, whether in a conference room or in a classroom. In all cases, the presenter must control the flow of the presentation in some way. In most cases this is done by standing in front of a computer and using a mouse and keyboard at a fixed console. In many cases, a presenter can give a more exciting and immersive presentation if he or she has freedom of motion during the presentation. The Smart Presentation Remote will enable this and provide a better experience for both the presenter and the audience.

A number of commercial presentation remote solutions already exist. A trip to any electronics store will reveal that simple remotes that only allow the presenter to advance and reverse slides can be had ranging in price from $50 to $100. While these remotes are easy to use and meet the needs of many people, power users continue to demand products with more features. There are presentation remote applications that run on smartphones like Android and iPhone. These applications add integration with the presentation software and enable features impossible with simple remotes such as being able to view the notes page for each slide. These applications, however, require an expensive smartphone to run on and rapidly deplete the phone's battery. As a solution, we offer the Smart Presentation Remote, a discrete presentation remote that provides advanced features and integrates with popular presentation software.

TECHNICAL OBJECTIVES

The Smart Presentation Remote is the fusion of a hardware remote with a host computer server. Listed succinctly our technical objectives fall under the categories of hardware specifications and host computer software. We also provide a comparison of our product with existing commercial solutions.

REMOTE HARDWARE SPECIFICATIONS AND POWER CONSUMPTION

Our product integrates a number of electronic components into a compact form factor. One feature of the remote will be the ability to control the mouse on the computer. This was accomplished using a triple-axis gyroscope which provides a digital-16 bit output signal via a 2-wire (I^2C) interface. In standard operating mode, the gyroscope consumes approximately 6.5 mA and runs at 3.3 V. We used a Rayson BTM-182 Bluetooth module to interface with the host computer over a virtual COM port interface. Bluetooth was chosen as it is both relatively simple to implement and compatible with a wide range of computer systems. The Bluetooth module runs at 3.3 V and consumes 58 mA of current during transmission at peak power, while consuming far less during other operations. A distinguishing feature of our product is that it has an on-remote display. The LCD display on the remote is an ST7565 graphic LCD with 128x64 resolution. The ST7565 LCD module consumes 120 mA at 3.3 V. Our microcontroller is the Atmel AVR Xmega (ATxmega192A3). This chip was chosen because it has a large number of USARTs and consumes a minimal amount of power. It can also be easily programmed using a free GNU-based toolchain. The Xmega consumes 18.4 mA at a nominal supply voltage of 3.0 V. Finally, have a laser pointer on our handheld unit. This is separated from the rest of the electronics and will have a simple analog circuit controlling it. The laser diode is rated at 5 mW and runs at 3.3V. To supply power to the device, we installed a 900 mAh lithium ion battery and MAX1555 recharging IC to charge the device over a USB port.

HOST COMPUTER SOFTWARE

The host computer software is an application to receive data from the remote and convert this data into keystrokes and mouse movements to control the presentation. Additionally, it will process information from user-provided text files and send it to the remote. Communications will take place over a virtual COM port implemented by the Windows Bluetooth stack. Using this framework allowed us to rapidly interface our host computer with the microcontroller utilizing techniques similar to those covered in our microprocessors applications course.

While our device is only compatible with the Windows operating system and PowerPoint-like software, we designed and documented the communications protocol in such a manner that our product will be easily adaptable to a wide range of operating systems and software packages. Theoretically, our serial protocol is completely platform agnostic and can be implemented on any platform implementing a Bluetooth stack.

COMMERCIAL ALTERNATIVES

A number of commercial alternatives currently exist to the Smart Presentation Remote. A number of manufacturers make simple 2.4 GHz remotes that simulate key presses to advance slides, blank the screen, and perform a number of other very basic functions in PowerPoint. While gyroscopic computer mice have existed for over ten years, the interface was made popular by the Nintendo Wii game console controller. A number of guides exist on the Internet for using a Wii controller with a vibrating structure MEMS gyroscope add-on (Wii MotionPlus) as a gyroscopic mouse that can be used to control PowerPoint. There are applications for both iOS (iPhone) and Android mobile computing platforms that allow presenters to view some parts of the presentations on their mobile phones with extra metadata such as slide notes and timing while giving a presentation. Our research has not uncovered any discrete device that enables this functionality. This differentiates our product from all commercially available solutions.

FLOWCHARTS AND DIAGRAMS

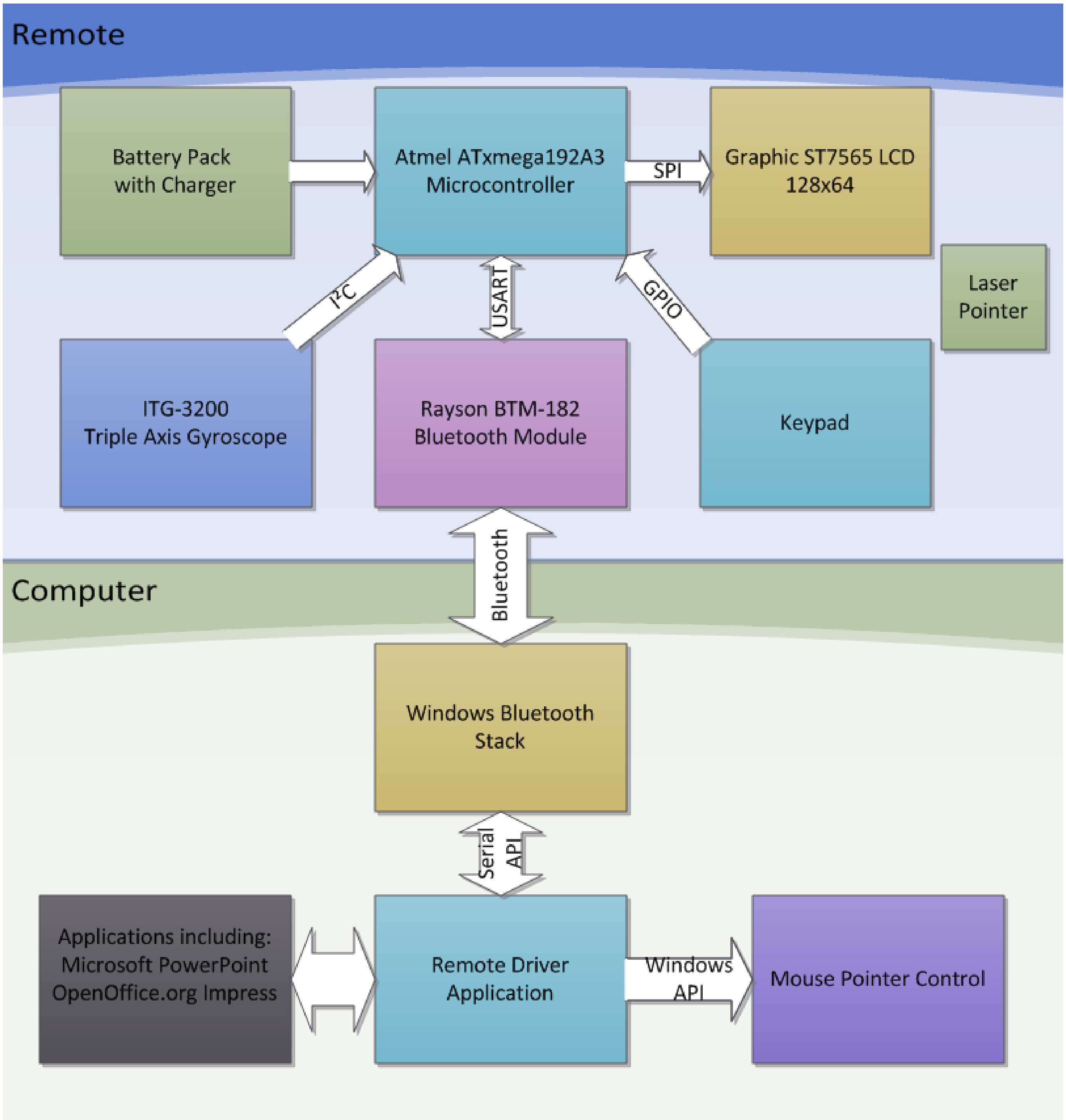

Figure 1 Project Block Diagram

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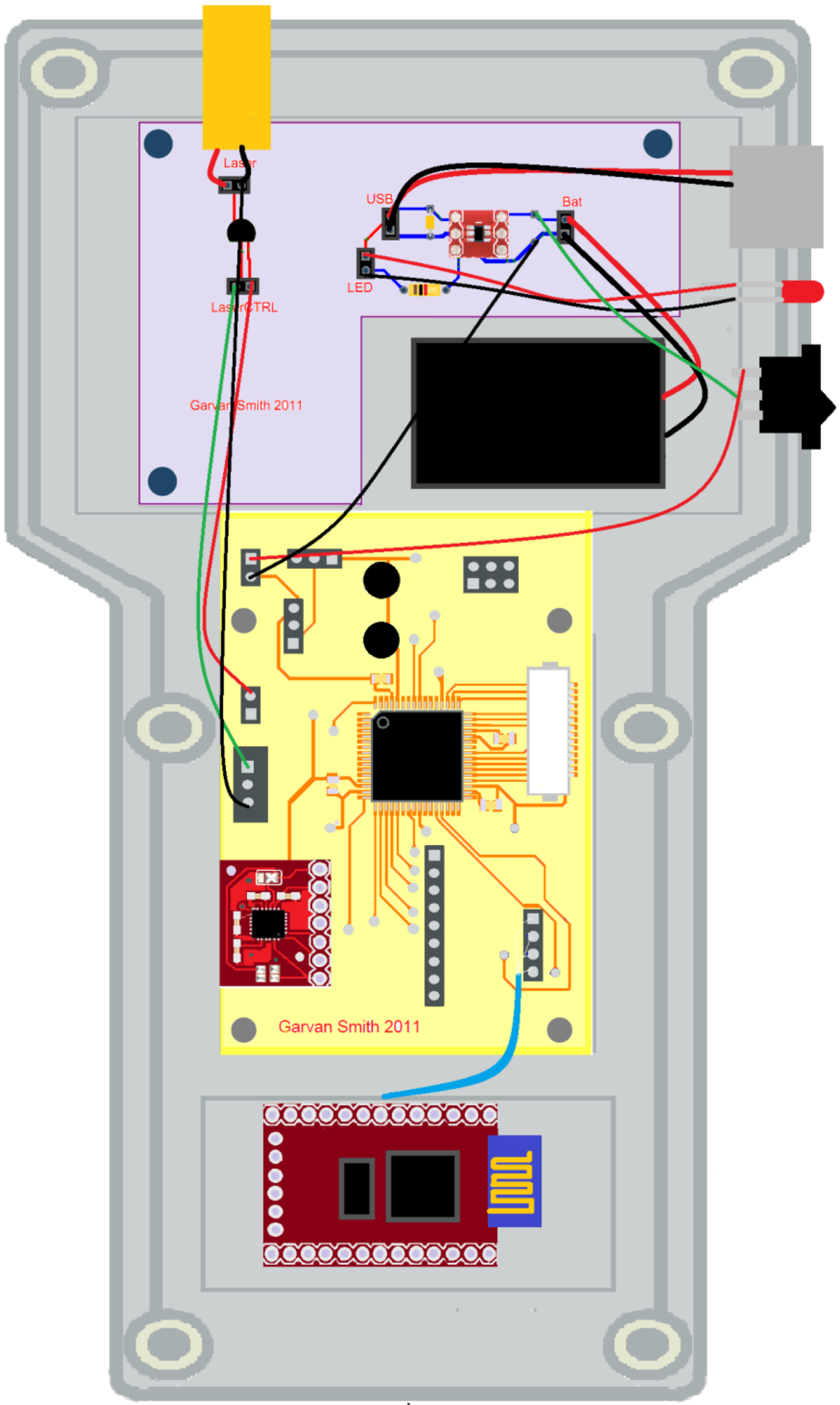

Figure 2 Internal Layout of Remote

SOFTWARE

OVERVIEW

The Smart Presentation Remote requires software to run on both the Atmel Xmega microcontroller as well as the host PC. Interfacing between the applications is done through Bluetooth. The microcontroller communicates through a Bluetooth UART device and the host PC connects to the device and treats it as a virtual COM port. Throughout the semester, we have written a functional remote control application that demonstrates the capabilities of our device, but the framework was not easily extensible.

MICROCONTROLLER PROGRAM

Our microcontroller program is relatively simple. It starts by initializing all the peripherals and drivers. It also draws the Gator Engineering logo to the screen on startup to demonstrate the features of the graphical LCD. The body of the program runs in a continuous loop in which it polls the gyroscope over I^2C. It also checks the keypad. Debouncing the keypad is performed by only transferring the keypad value during an interrupt routine which will be described later.

Interrupts are used to control the rest of the microcontroller program. The real-time clock is configured to generate interrupts at a rate of 8 Hz to transmit the keypad and gyroscope data to the host computer using the Xmega USART. The device implements a set of control words to manipulate device functionality from the host computer software. The final version of the software implements control bytes for the following features:

1. Clear screen buffer
2. Move screen buffer pointer to next line
3. Render and draw text to screen
4. Laser pointer toggle

The current implementation is based on using the Bluetooth TX interrupt and transferring each read character (except control characters) to a small text buffer. When the render command is issued, the text is drawn to the screen. Rendering the LCD contents is performed through the driver provided for the screen.

A flowchart for the primary functionality of the driver program is provided below:

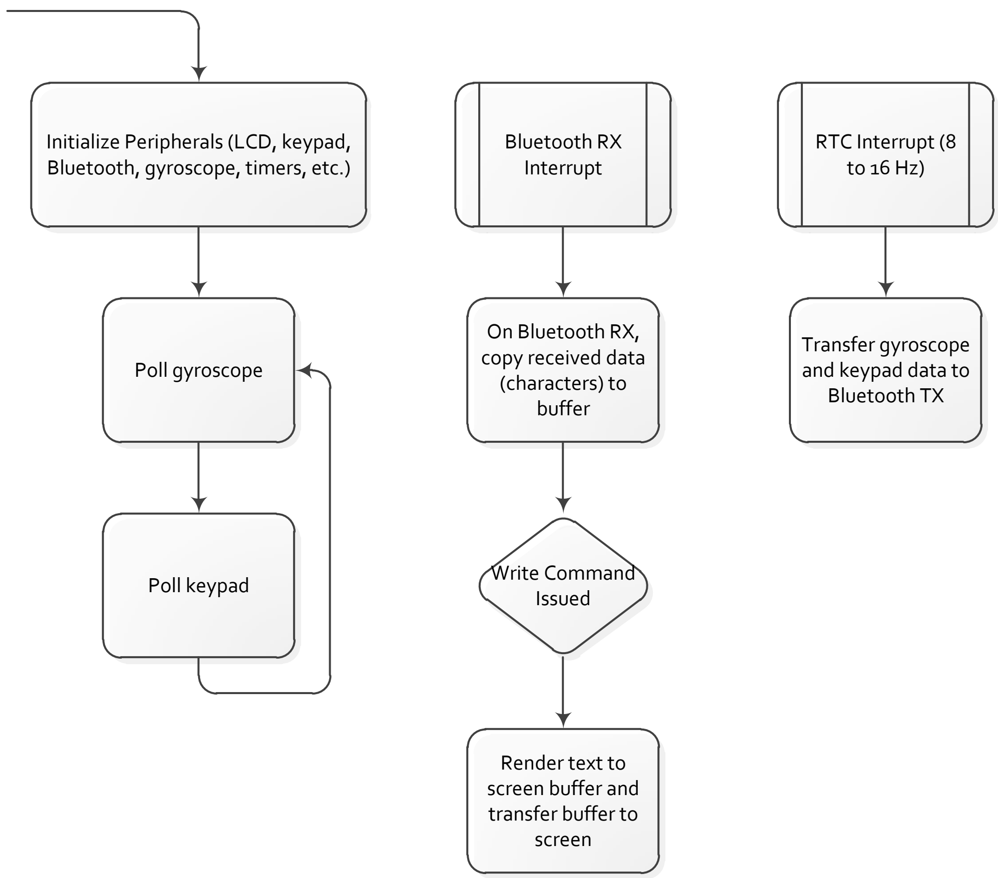

Figure 3 Microcontroller Application Flowchart

DRIVER APPLICATION

The driver application for the PC is written in C# using Visual Studio 2010. A preliminary version of the driver just polled the virtual COM port to which the Bluetooth device was connected and moved the mouse based upon gyroscope readings. It could also emulate keyboard events and allow for simple control of a PowerPoint presentation. To demo writing to the screen, the program would place a clock on the screen as well as the current location of the mouse cursor. The old version of the program was very useful for testing purposes, but had to be completely rewritten from the ground up to allow for a more extensible software architecture.

The new version of the software features a graphical user interface for the driver that allows the user to easily connect to the remote and choose a premade control profile for the remote Using a text editor a profile can be created that enables the following features to be accessed on the remote control:

1. Bind keys on the remote to keyboard events and mouse events.
2. Bind gyroscope readings to mouse movements with a specified gain (sensitivity) or other input events with a specified threshold.

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3. Enable the timer feature. This can either be a simple clock or a stopwatch with start, stop, and reset buttons.
4. Enable the notes feature. Notes are selected from a menu in the GUI.
5. Enable the "buzzword" feature. A file containing buzzwords is selected in the GUI.

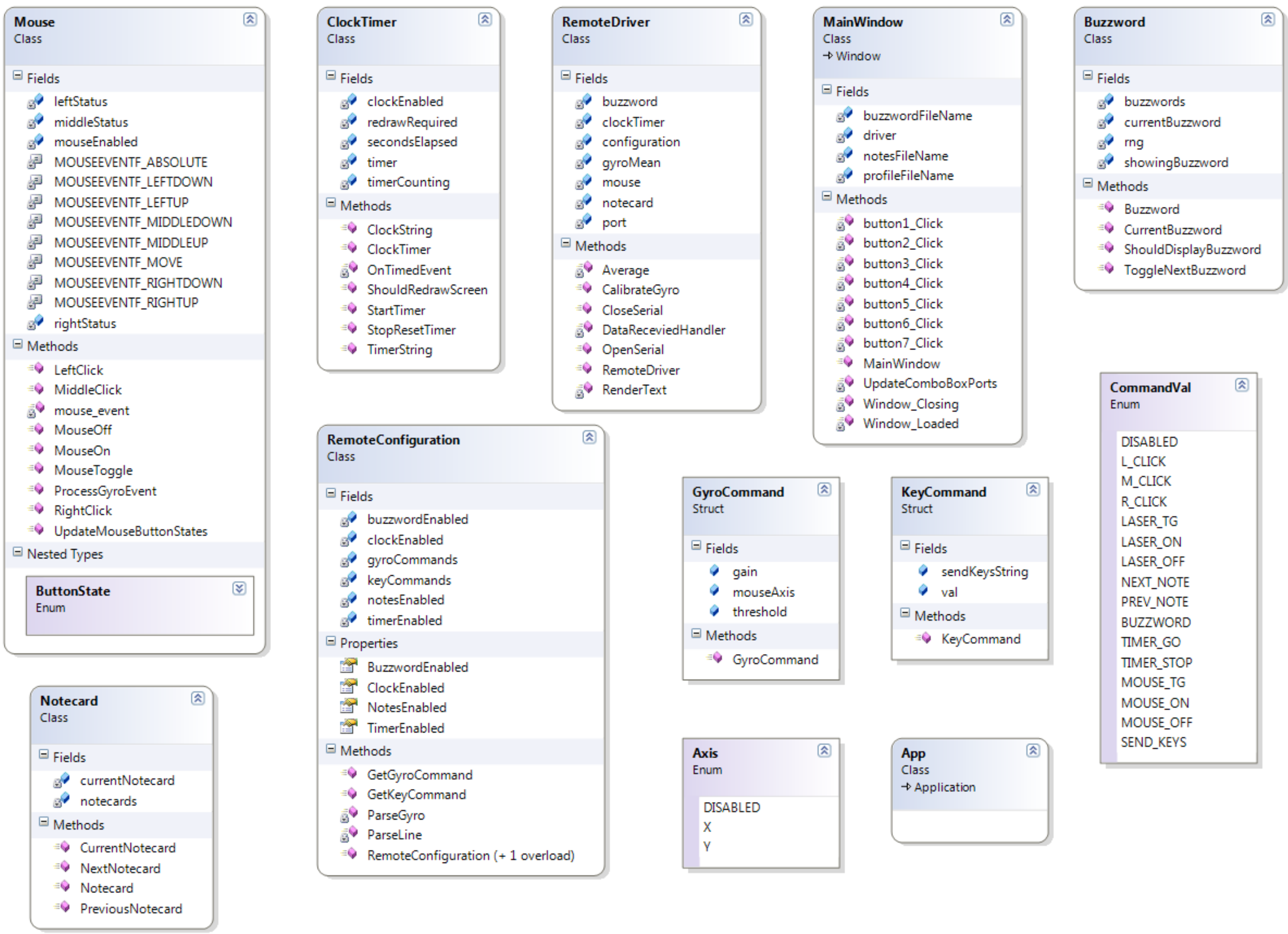

Figure 4 Visual Studio Class Diagram

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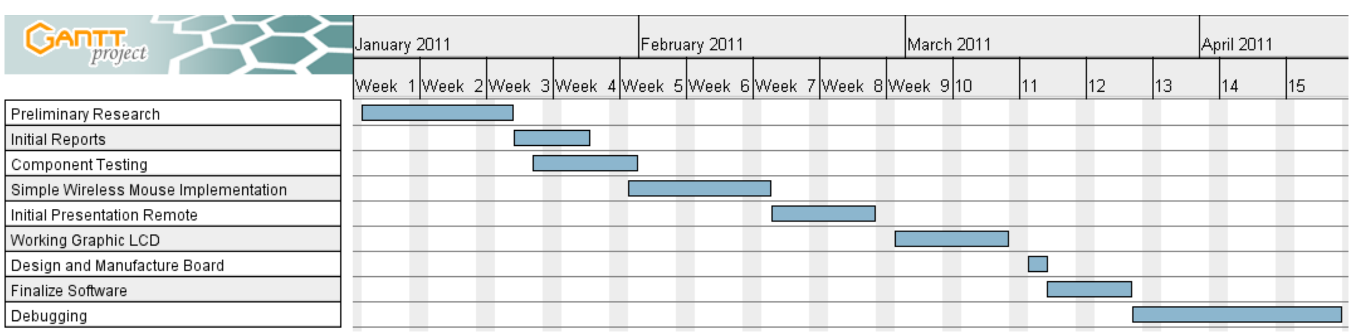
DIVISION OF LABOR

Table 1 Division of Labor

	Margaret Garvan	Samuel Smith
Preliminary Research	50	50
Purchasing Components	50	50
Documentation	50	50
Initial Component Testing	50	50
Microcontroller Programming	50	50
Driver Programming	20	80
Board Design	60	40
Housing Design	80	20
Manual Assembly	60	40
Testing and Debugging	50	50
Final Presentation	50	50

GANTT CHART

Table 2 Gantt Chart



COST OBJECTIVES

We spent around $500 on our project including materials purchased for testing purposes. If the device were to be mass-produced, we could feel that we could easily manufacture for around $70 per unit.

REFERENCES

1. Bluetooth Module http://www.sparkfun.com/datasheets/Wireless/Bluetooth/BTM182.pdf
2. ATxmega192A3 Product Card http://www.atmel.com/dyn/products/product_card.asp?part_id=4303
3. AVR Studio 4 http://www.atmel.com/dyn/products/tools_card.asp?tool_id=2725
4. Graphic ST7565 LCD http://www.adafruit.com/index.php?main_page=product_info&cPath=37&products_id=250
5. MAX1555 Battery Charger http://www.sparkfun.com/products/674
6. ITG-3200 3-Axis Gyroscope http://www.sparkfun.com/products/9801
7. Visual Studio 2010 http://www.microsoft.com/visualstudio/en-us/products/2010-editions
8. MSDN Library http://msdn.microsoft.com/en-us/library/
9. Nintendo Wii Controller with Accelerometer and Gyroscopes http://www.nintendo.com/wii/console/controllers
10. Kensington Wireless Presenter Remote http://us.kensington.com/html/11189.html
11. Apple Keynote Remote for iPhone http://itunes.apple.com/us/app/keynote-remote/id300719251?mt=8
12. Android PowerPoint Remote http://www.pptremotecontrol.com/

MATERIALS AND RESOURCES

The components used in the final remote were:

Description	Price	Purchased From
Bluetooth – Rayson BTM- 182	$34.95	Sparkfun
Triple Axis Gyroscope ITG - 3200	$49.95	Sparkfun
LCD – Graphic ST7565 LCD	$15.25	Adafruit
ATxmega192A3	$11.52	Digikey
Keypad – sealed membrane switches	$16	Sparkfun
Keypad Connector	$0.95	Sparkfun
Enclosure	$13.28	Pactec Enclosures
Battery – Li Ion Single Cell	$2	Radio Shack
Laser	$16	Digikey
Caps/Resistors/BJT	$0	Covered by lab fee

Additionally a PCB from Advanced Circuits was used for the main board. This was about $50 with shipping. A PCB for the analog components was made in-house. For a device in mass production, the above costs could be greatly reduced by buying in bulk and not using break-out boards for components.

APPENDIX A: COMMAND AND FILE STRUCTURE

REMOTE COMMAND BYTES

Sending these command bytes to the remote will result in the following actions:

0x03 Clear screen buffer

0x04 Render screen buffer

0x05 Laser toggle

0x06 Laser on

0x07 Laser off

0x0A New line on screen buffer (value of \n)

PROFILE STRUCTURE

Each line will begin with an identifier, either a number 1-27 identifying a key, or gy.{x,y,z} indicating a particular gyroscope axis. After that arguments must be listed identifying an event that should occur when each button is pressed or a mouse configuration for the gyroscope.

KEYPAD EVENT STRUCTURE

[KeyNumber] "[string sent to SendKeys]"

[KeyNumber] [Event_name]

For example,

1 "A"

This line will map button 1 (F1) to the "A" key.

2 l_click

This line will map button 2 (left arrow) to the left click action.

Only a single event can be mapped to each key, but with a SendKeys action, a string of characters can be sent. For example, you can map a button to send "%{F4}" (Alt+F4), but this key cannot also toggle the laser pointer, for example. To send the quotation mark character, no escaping is needed. The parser will look for the last quotation mark character in the line as the terminator. For details of how the method works internally and a complete list of escape sequences, see:

http://msdn.microsoft.com/en-us/library/system.windows.forms.sendkeys.send.aspx

GYROSCOPE EVENT STRUCTURE

gy.[axis] [mouse axis] [floating point gain] [threshold]

For example,

gy.x x 2.5 3

This will map the x axis of the gyroscope to the x mouse axis with a gain of 2.5 pixels per gyroscope tick with a threshold of 3 ticks.

gy.z y -3 4

This will map the z axis of the gyroscope to the y mouse axis with a gain of 3 pixels per gyroscope tick with a noise threshold of 4 ticks, but moving the mouse in the negative direction with positive gy.z values.

Each gyroscope axis can only be mapped to a single mouse axis, but multiple gyroscope axes can be mapped to the same mouse axis.

OTHER FEATURES

To enable the timer, clock, notes, and buzzword features, add the words TIMER, CLOCK, NOTES, BUZZWORD on a separate line for each feature at the bottom of the file. Note that the appropriate keys need to be mapped for each feature to work. Also be aware that all features take up at least one line of space on the screen at all times. Comments are not supported in profile files at this time.

COMPLETE LIST OF SPECIAL KEY EVENTS

These commands are not case sensitive.

Command	**Description**
L_CLICK	Mouse left click.
M_CLICK	Mouse middle click
R_CLICK	Mouse right click
MOUSE_TG	Mouse toggle
MOUSE_ON	Mouse on
MOUSE_OFF	Mouse off
LASER_TG	Laser toggle
LASER_ON	Laser on
LASER_OFF	Laser off
NEXT_NOTE	Next notecard
PREV_NOTE	Previous notecard
BUZZWORD	Show next random buzzword
TIMER_GO	Start timer
TIMER_STOP	Stop timer, reset if stopped

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NOTECARD AND BUZZWORD FILE STRUCTURE

The notecard and buzzword files should be plain text documents with no special characters. For the notecard file, each note should appear on a separate line. Notes are limited by the parser to 168 (8 rows, 21 columns) characters, though the whole note might not be visible if other features are enabled. The buzzword file is simply a list of buzzwords with a separate word on each line. Newlines and other special characters are not permitted in buzzwords or notecards. Wrap around is not handled as the screen is not really very wide.

LIST OF REMOTE KEY NUMBERS

Key	Button
1	F1
2	<-
3	SEND
4	4
5	8
6	F2
7	OK
8	CLEAR
9	5
10	9
11	F3
12	->
13	1
14	6
15	*
16	+
17	-
18	2
19	7
20	0
21	↑
22	↓
23	3
24	
25	#
26	F4
27	MENU
28	
29	
30	
31	
32	
33	
34	
35	
36	END

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SAMPLE REMOTE CONFIGURATION FOR POWERPOINT

Button	Function	Keyboard Map
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
F1	Timer ON	
F2	Timer Stop/ CLEAR	
F3	Mouse Toggle	
F4	Start Presentation	F5
↑	Next Note	
↓	Previous Note	
←	Previous Slide	Page Up
→	Next Slide	Page Down
+	Mouse Left Click	
-	Mouse Right Click	
SEND	Show or Hide Pointer	A
CLEAR	Black Screen	B
MENU	Switch Application	ALT+ TAB
END	END Presentation	ESC
*	Laser Toggle	
#	Buzzword Toggle	
OK	Enter Key	ENTER

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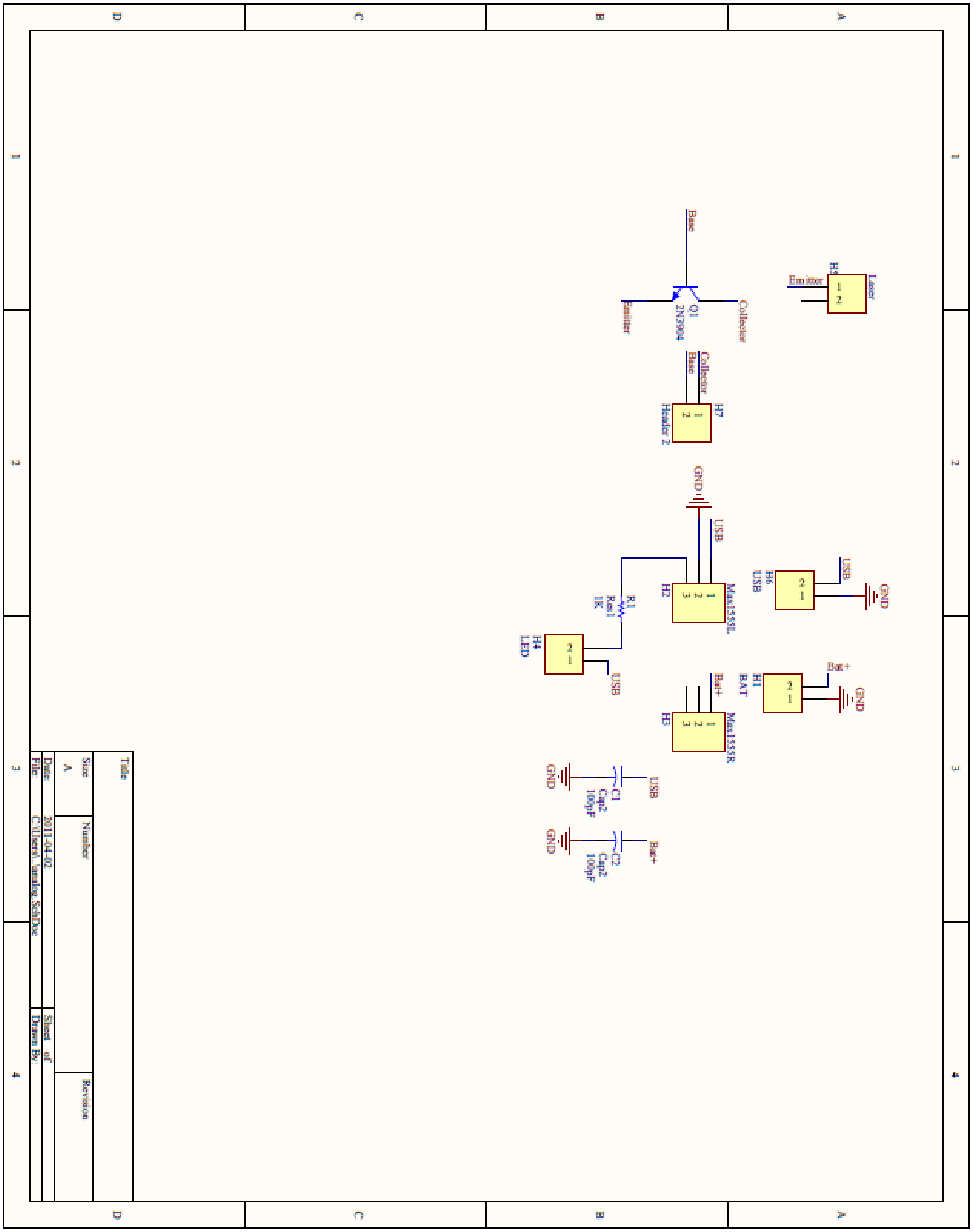
APPENDIX B:PCB SCHEMATICS AND LAYOUTS



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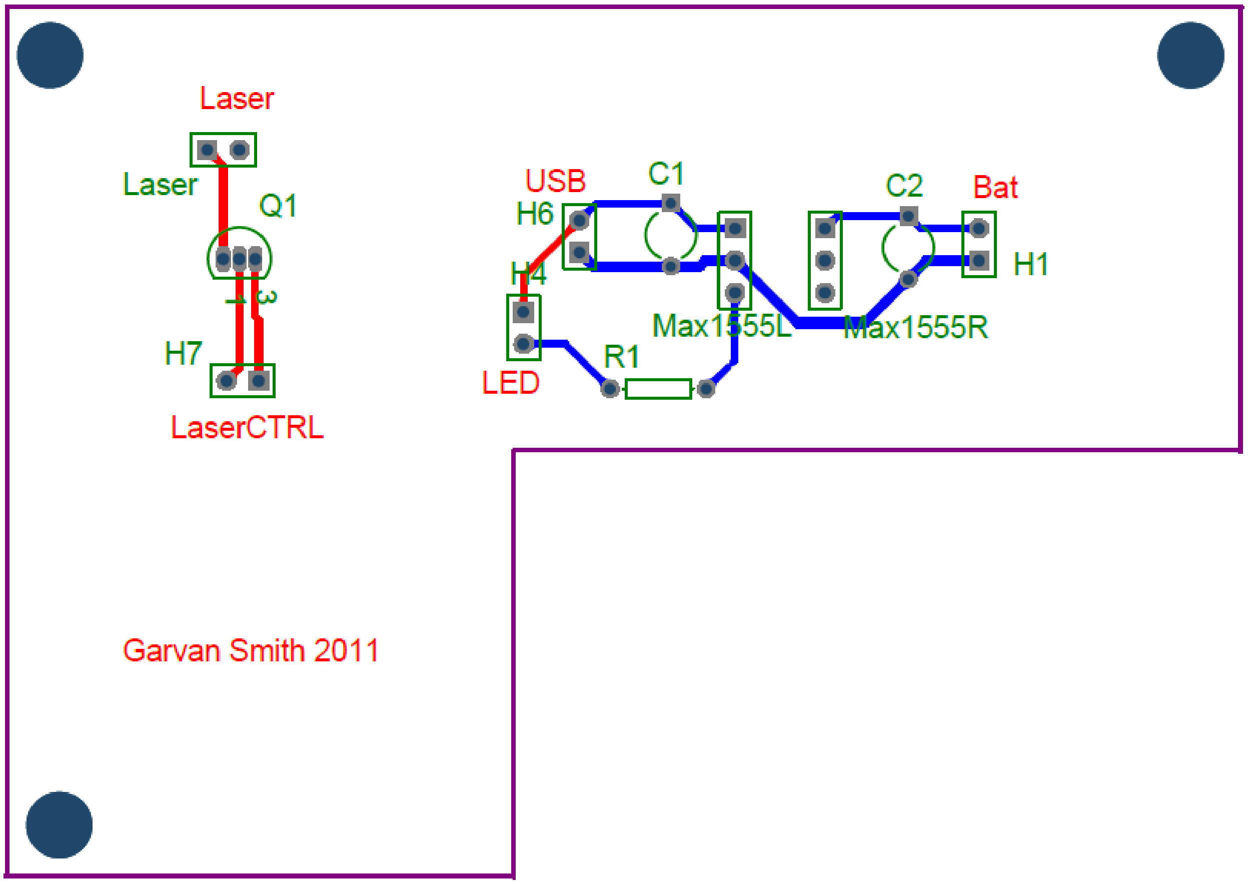

Figure 5 Analog PCB

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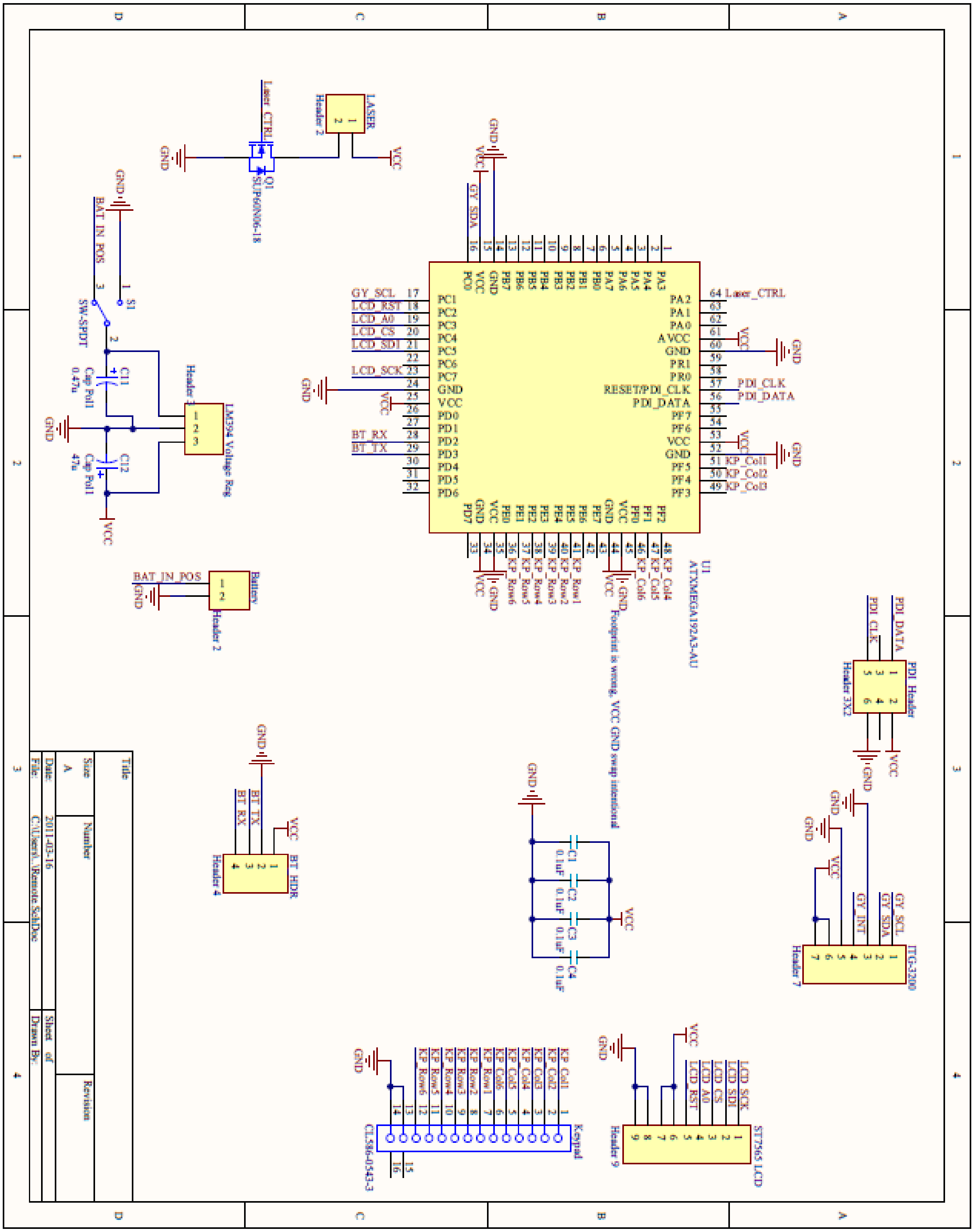

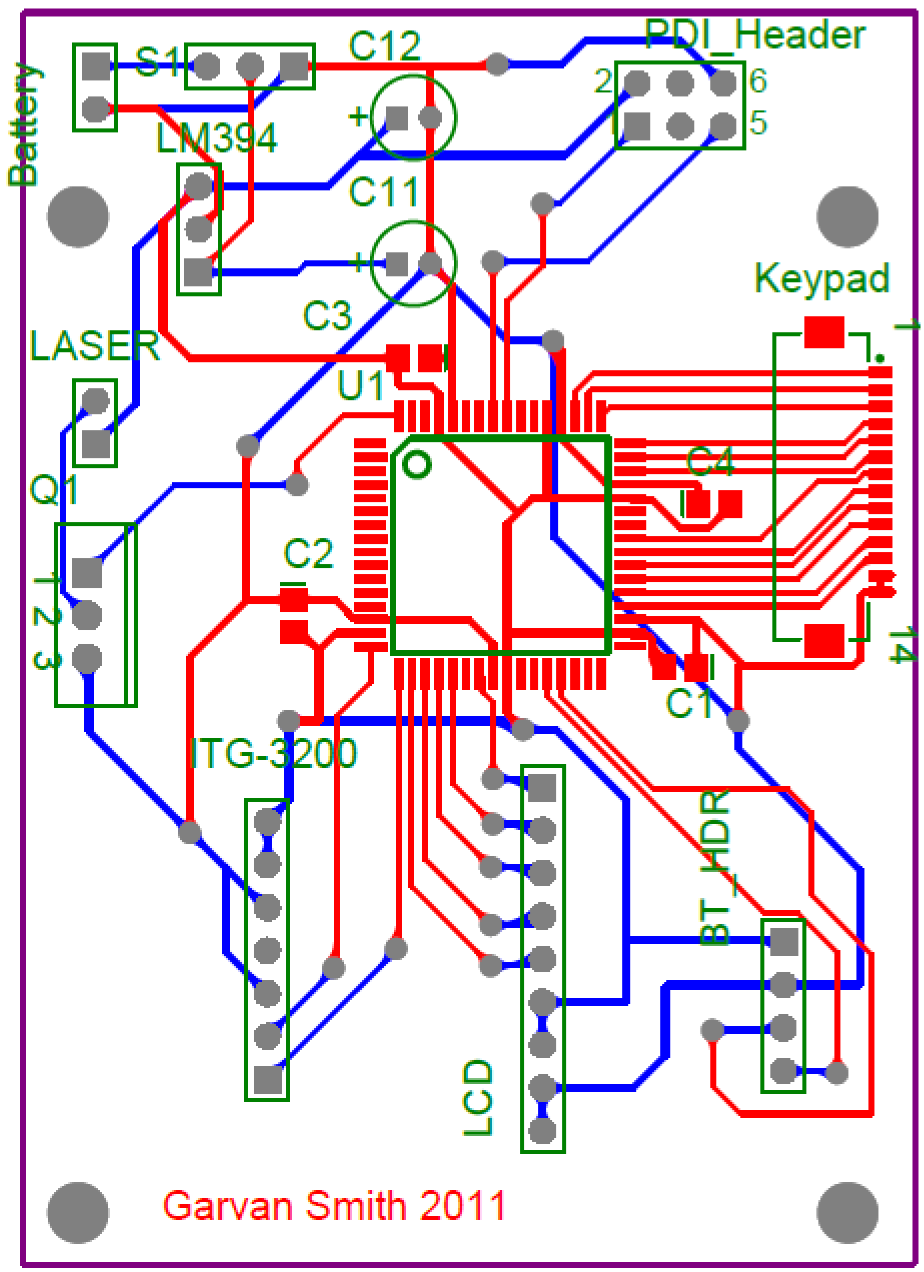

Figure 6 Main PCB

APPENDIX C: MICROCONTROLLER CODE

```
/* Remote.c
   This is the main source file for the remote application.
   Margaret Garvan and Samuel Smith
   EEL4924 Spring 2011
#define F_CPU 32000000UL

#include <stdio.h>
*/


#include <stdlib.h>
#include "clksys_driver.h"
#include "usart_driver.h"
#include "bluetooth.h"
#include "spi_driver.h"
//#include "hitachi_lcd.h"
#include "port_driver.h"
#include "accelerometer.h"
#include "string.h"
#include "glcd.h"
#include "stlcd.h"
#include "keypad.h"

#include "gyroscope.h"

//Initialize prototypes
void clock_init(void);


uint8_t ST7565_buffer[128*64/8];
char text_buffer[168];
int  text_pointer;
gyro  myGyro;
//accel myAccel;
uint8_t key;

int main(void)
{
      clock_init();
      bluetooth_init();
      init_gyro();
    st7565_init();
    setup(); // for graphic LCD screen
      init_keypad();
      PORT_SetPinsAsOutput(&PORTA, 0x04);       //Set PORTB as output for Laser
CTRL
    init_rtc();
    sei(); //enables interrupts


      while(1)
      {
         myGyro  = get_gyro();
```

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```
      //     PORT_SetPins( &PORTA, 0x04 );// ON LED (or laser)

    }
      return 0;
}


void clock_init(void)
//From Sparkfun sample code
{
    CLKSYS_Enable( OSC_RC32MEN_bm ); //32MHz
      CLKSYS_Prescalers_Config( CLK_PSADIV_1_gc, CLK_PSBCDIV_1_1_gc );
      do {} while ( CLKSYS_IsReady( OSC_RC32MRDY_bm ) == 0 );
      CLKSYS_Main_ClockSource_Select( CLK_SCLKSEL_RC32M_gc );
      CLKSYS_Disable(OSC_RC2MCREF_bm);
      CLKSYS_AutoCalibration_Enable(OSC_RC32MCREF_bm,1);
}

//Timer overflow interrupt routine running at 8 Hz
ISR(RTC_OVF_vect)
{

      key = scan_keypad();

      bluetooth_int(myGyro.x);
      bluetooth_char(' ');
      bluetooth_int(myGyro.y);
      bluetooth_char(' ');
      bluetooth_int(myGyro.z);

      bluetooth_char(' ');
      bluetooth_int(key);

      bluetooth_char('\r');
      bluetooth_char('\n');
      //bluetooth_receive();




}
ISR(USARTD0_RXC_vect){
  char value = USARTD0.DATA;

  if(text_pointer >= 168)
            text_pointer = 0; //prevent buffer overflow

  if (value == 0x03){ //clears text buffer

      for(int i = 0; i< 168; i++ ){
            text_buffer[i] = ' ';
      }
      text_pointer=0;
      return;
```

```
  }
  else if(value == 0x05){ //Laser Toggle
     PORT_TogglePins( &PORTA, 0x04 );// toggle LED (or laser)
  }
   else if(value == 0x06){ //Laser ON
     PORT_SetPins( &PORTA, 0x04 );// ON LED (or laser)
  }
  else if(value == 0x07){ //Laser OFF
     PORT_ClearPins( &PORTA, 0x04 );// OFF LED (or laser)
  }
  else if(value == '\n'){
     text_pointer = (text_pointer/21 + 1) * 21;

  }

  else if(value == 0x04){
    clear_buffer(ST7565_buffer);
      drawstring(ST7565_buffer, 0,0, text_buffer);
      write_buffer(ST7565_buffer);


  }
  else if(value == 0x0D){
     text_pointer = (text_pointer/21 ) * 21;
  }
  else
  {
        text_buffer[text_pointer++] = value;

  }
}
```