Non-Contact Vital Sign Monitoring System: Proposal Presentation

Zachary Lasater (Group Leader)
Andrew Renuart (Webmaster)
Ahmed Elsabbagh
Anthony Genutis
Julian Rosker

Motivation

Heart & respiration rates:

- More Accurate
- Cheaper
- Non-obtrusive
- More Readily Available
- Viable

Sleep Apnea Accessibility

Burn Victims

Environmental Factors

Interference

Objective

- Use the existing antennas and function generator to build a system that will report heart and respiration rates of a user in real time without physical contact with aforementioned user.

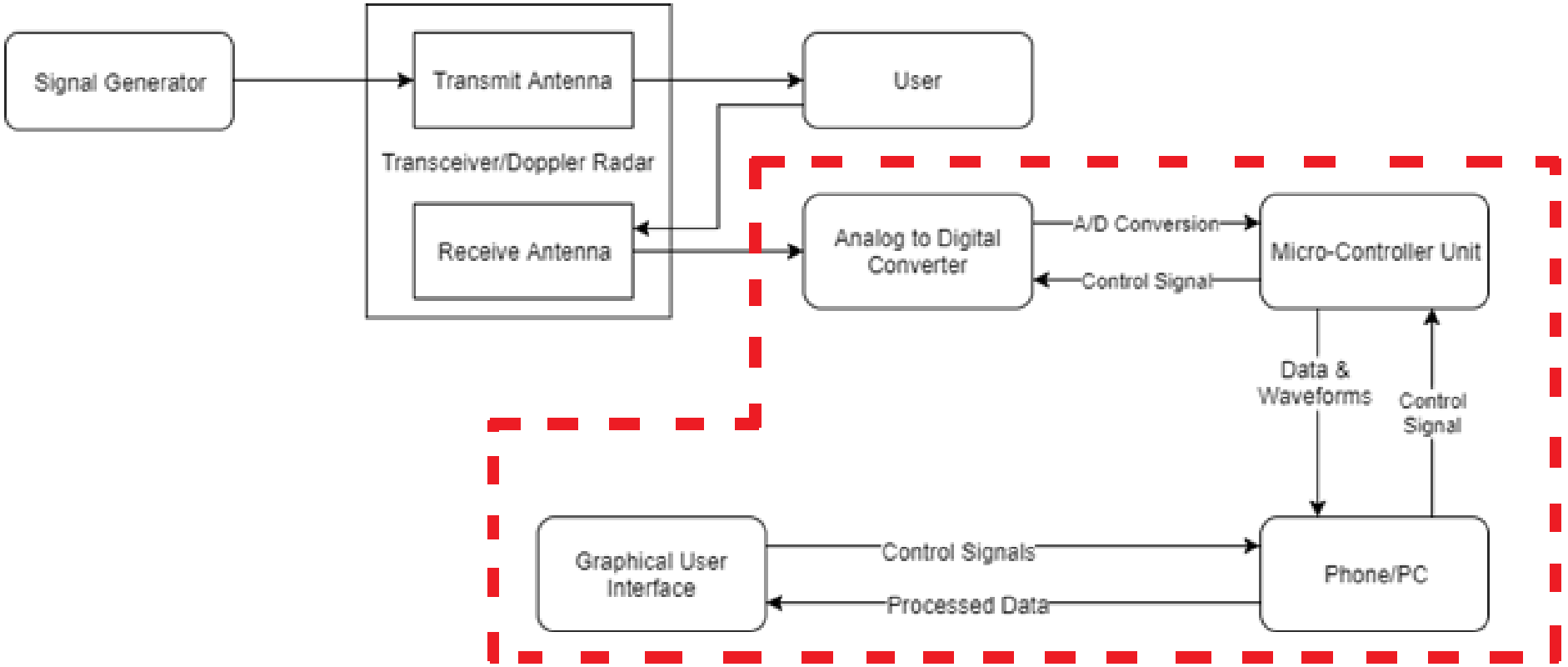
Goals

- Heart & respiration rates:
  - Easy to interpret
  - Easy to setup
  - Real Time
  - Cheap
  - Convenient

Components

- Signal Generator
- Antennas
- ADC
- MCU
- PC software & GUI
- Communication Protocols

Block Diagram



Target Specifications

ADC Specifications

Feature	Specification
Bits of resolution	>= 16
Number of Channels	8
Sampling Rate	>=1000 samples/second
Power Supply	< 5.0V
Size	Nothing specific, but able to be portable

MCU Specifications

Feature	Specification
SPI data rate	> 24 kB/s
Microcontroller to PC interface	USB >= 2.0
Data Processing Ability	Dedicated Floating Point Unit
Power Supply	< 5.0V
Size	Nothing specific, but able to be portable

Target Specifications (continued)

PC and Signal Processing Specifications

Feature	Specification
Software requirements	MATLAB >=2017a
Operating System	Windows 7+
Communications Port	USB >= 2.0
Data Processing Ability	Real-time signal processing
Display and Plotting Capabilities	Real-time plotting of analyzed data
Size	Nothing specific, but able to be portable

Design Approach (Device Side)

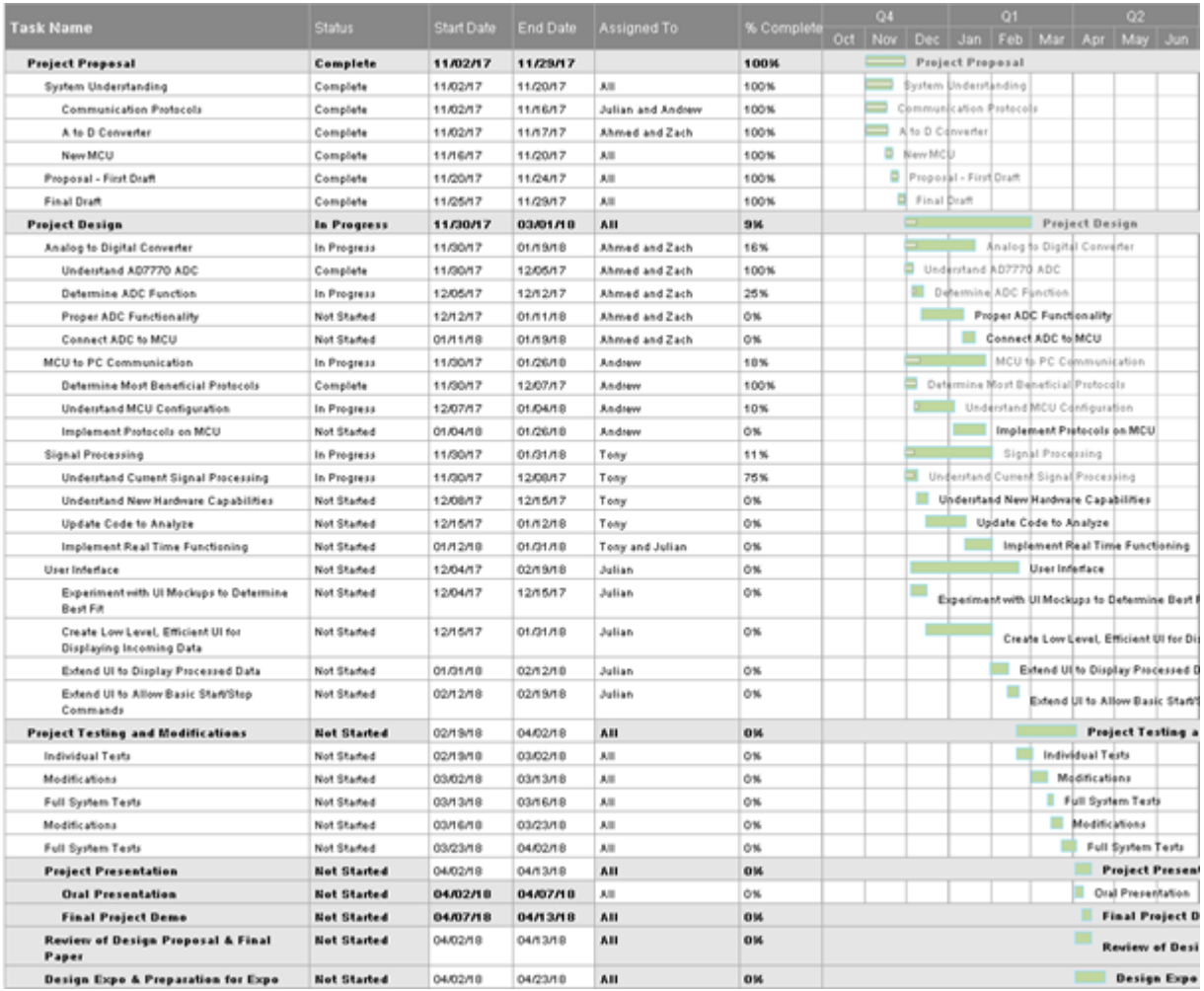
- Communication Between ADC and MCU
  - Will get SPI working on ADC and MCU and confirm that SPI has adequate speed.
- MCU data handling
  - Program MCU to mediate data transfer between ADC and PC.
  - Will determine an encoding method for data transfer over the COM port.
- Communication Between MCU and PC
  - Will get virtual COM port working between the MCU and PC and confirm that the protocol has an adequate data transfer rate.

Design Approach (PC Side)

- Extend current plotting and analysis to analyze and display real-time data.
  - Will use MATLAB for analysis and either MATLAB or Python for plotting.
- User Interface
  - Improve usability and add additional options, such as selecting which COM port to read.
- Create basic Android application to fetch and display analyzed user data.

Schedule

- Project Design completed by March 1
- Project Testing and Modifications completed by April 2
- Oral Presentation and Demo given by April 13



	Task Name	Status	Start Date	End Date	Assigned To	% Complete
1	**Project Proposal**	**Complete**	**11/02/17**	**11/29/17**		**100%**
2	System Understanding	Complete	11/02/17	11/20/17	All	100%
3	Communication Protocols	Complete	11/02/17	11/16/17	Julian and Andrew	100%
4	A to D Converter	Complete	11/02/17	11/17/17	Ahmed and Zach	100%
5	New MCU	Complete	11/16/17	11/20/17	All	100%
6	Proposal - First Draft	Complete	11/20/17	11/24/17	All	100%
7	Final Draft	Complete	11/25/17	11/29/17	All	100%
8	**Project Design**	**In Progress**	**11/30/17**	**03/01/18**	**All**	**9%**
9	Analog to Digital Converter	In Progress	11/30/17	01/19/18	Ahmed and Zach	16%
10	Understand AD7770 ADC	Complete	11/30/17	12/05/17	Ahmed and Zach	100%
11	Determine ADC Function	In Progress	12/05/17	12/12/17	Ahmed and Zach	25%
12	Proper ADC Functionality	Not Started	12/12/17	01/11/18	Ahmed and Zach	0%
13	Connect ADC to MCU	Not Started	01/11/18	01/19/18	Ahmed and Zach	0%
14	MCU to PC Communication	In Progress	11/30/17	01/26/18	Andrew	18%
15	Determine Most Beneficial Protocols	Complete	11/30/17	12/07/17	Andrew	100%
16	Understand MCU Configuration	In Progress	12/07/17	01/04/18	Andrew	10%
17	Implement Protocols on MCU	Not Started	01/04/18	01/26/18	Andrew	0%
18	Signal Processing	In Progress	11/30/17	01/01/18	Tony	11%
19	Understand Current Signal Processing	In Progress	11/30/17	12/08/17	Tony	75%
20	Understand New Hardware Capabilities	Not Started	12/08/17	12/15/17	Tony	0%
21	Update Code to Analyze	Not Started	12/15/17	01/12/18	Tony	0%
22	Implement Real Time Functioning	Not Started	01/12/18	01/01/18	Tony and Julian	0%
23	User Interface	Not Started	12/04/17	02/19/18	Julian	0%
24	Experiment with UI Mockups to Determine Best Fit	Not Started	12/04/17	12/15/17	Julian	0%
25	Create Low Level, Efficient UI for Displaying Incoming Data	Not Started	12/15/17	01/01/18	Julian	0%
26	Extend UI to Display Processed Data	Not Started	01/01/18	02/12/18	Julian	0%
27	Extend UI to Allow Basic Start/Stop Commands	Not Started	02/12/18	02/19/18	Julian	0%
28	**Project Testing and Modifications**	**Not Started**	02/19/18	04/02/18	**All**	**0%**
29	Individual Tests	Not Started	02/19/18	03/02/18	All	0%
30	Modifications	Not Started	03/02/18	03/13/18	All	0%
31	Full System Tests	Not Started	03/13/18	03/16/18	All	0%
32	Modifications	Not Started	03/16/18	03/23/18	All	0%
33	Full System Tests	Not Started	03/23/18	04/02/18	All	0%
34	**Project Presentation**	**Not Started**	04/02/18	04/13/18	**All**	**0%**
35	**Oral Presentation**	**Not Started**	**04/02/18**	**04/07/18**	All	0%
36	**Final Project Demo**	**Not Started**	**04/07/18**	**04/13/18**	**All**	**0%**
37	**Review of Design Proposal & Final Paper**	**Not Started**	04/02/18	04/13/18	**All**	**0%**
38	**Design Expo & Preparation for Expo**	**Not Started**	04/02/18	04/23/18	**All**	**0%**

Status

- Using an older ADC and present MCU, non-real-time analysis is currently possible with 12 bits of resolution.
- Only ~600 samples/second with the newer MCU, a major target is improving it to at least 1000 samples/second.
- Important Design Decisions:
  - Signal processing on the PC as opposed to on the MCU
  - Using SPI for communication between the MCU and the PC.

Equipment & Costs For Prototype

Product Description	Quantity	Unit Price ($)	Total Price ($)
497-15244 MCU Evaluation Board	1	316.80 [29]	316.80
EVAL-AD7770FMCZ ADC Evaluation Board	1	124.99 [30]	124.99
ACX1567 SMA Cable	2	11.00 [31]	22.00
931-1175 SMA Jack	2	3.22 [32]	6.44
WM9354 SMA Jack to SMB Plug	4	16.20 [33]	64.80
J635 SMB Terminator	4	18.20 [34]	72.80
Total Cost			**$607.83**