Pilot Biometrics

ECG WAVEFORM CAPTURES

Team Number: 18-12
Client: Rockwell Collins
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Revised: 9/21/2017 – V1

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1 Introduction

1.1 PROJECT STATEMENT

Pilot Biometrics ECG Waveform Captures is creating a device that will collect the ECG waveforms of a pilot. Our product will collect these wave forms and then filter out all the excess noise and interpret the waveform to detect if the pilot is unhealthy or should not be doing any intense maneuvers. Our product will communicate with the ground so they are able to monitor the pilot's health.

1.2 PURPOSE

The purpose of this project is to provide valuable feedback to pilots who may not be operating planes in a proper state. The vest that the pilot will wear will be providing real-time feedback to the pilot that they are in a stressful situation even if they are unable to determine so themselves. This is of course a benefit to society because pilots have a large amount of responsibility whether they are transporting people, goods, or fighting in a war and this technology will improve the quality of operation.

1.3 GOALS

- Design Review
- UNIX Installation
- Driver Creation
- Software Filter Design
- Algorithm Design
- ADC to Microcontroller Protocol
- Product battery life of greater than 4 hours
- Custom Printed Circuit Board Design
- Breakaway Harness Design
- Reliable Detection (No False Positives)

2 Deliverables

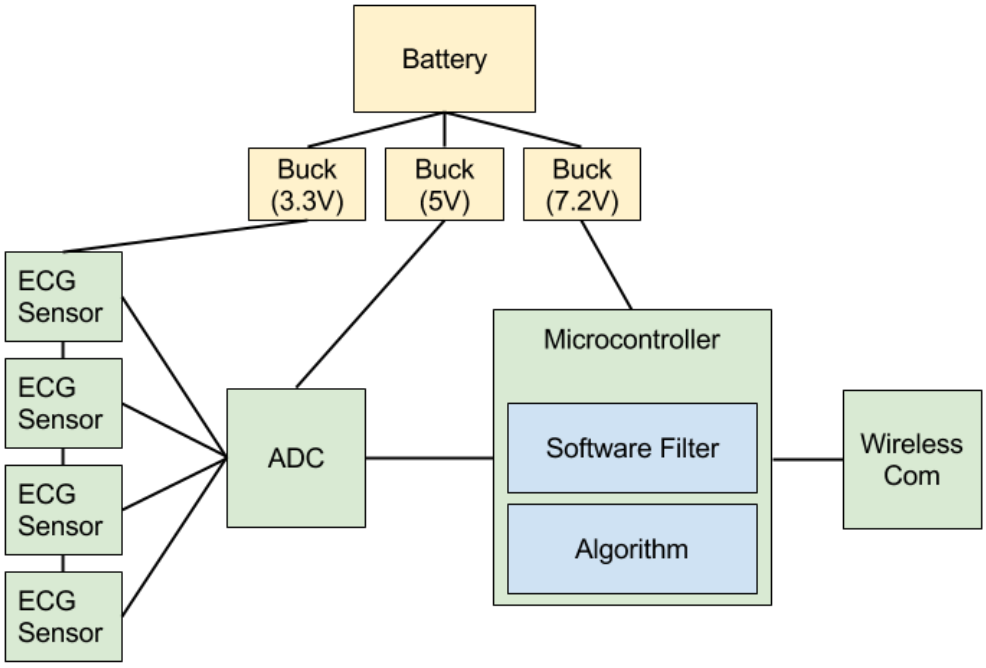
- Integrated Schedule/Timeline with Project Milestones
- A 4-Layer Printed Circuit board integrating the ADC and Microcontroller
- ECG Interpreter
- ECG sensor harness
- Power system to distribute power to hardware
- System block diagram

3 Design

3.1 PREVIOUS WORK/LITERATURE

There are several methods that have been documented for the ECG capturing. We will have to select or develop the method that best suits our needs for mental workload detection. The rest of our project follows once we determine our particular solution for how to filter the signal and then process it for feedback. Nothing else should require intensive investigative research.

3.2 PROPOSED SYSTEM BLOCK DIAGRAM



3.3 ASSESSMENT OF PROPOSED METHODS

One of the most difficult aspects of this project will be filtering all the background signals coming from the ECG sensor. To solve this issue, we were pointed towards a physical filter. After much consideration, we started to consider making a software based filter instead. We are leaning towards the software filter because it would be far less challenging to make, and the slower speed of the software filter will make very little difference in the overall system.

3.4 VALIDATION

To test our product, it will be tested while in flight to confirm our product works as intended and while in the real-world environment. Our client plans to use the University of Iowa's operator performance lab (OPL). This lab will provide us the opportunity to test our product and to get feedback from the pilot.

4 Project Requirements/Specifications

4.1 FUNCTIONAL

- Accurately detect a pilot in distress
- Detect stress (workload) of the heart
- 4-5 hours of continuous operation
- Notify pilot or ground station
- Store 4-5 hours of operational data

4.2 NON-FUNCTIONAL

- Don't get in the way of the pilot's primary tasks
    - Flying the plane
    - Emergency ejection

4.3 STANDARDS

Our project will abide by military standards for medical record data, as well as ECG waveform capture standards for data storage.

5 Challenges

The main challenges that our group foresee are difficulty researching and implementing the correct form of a filter to eliminate noise, figuring out what the specific purpose of the driver, testing our product once we have a prototype, and potential limitations to implementing a filter in the software. We are not worried about cost or materials since our contact has assured us that we are not limited by those.

6 Timeline

6.1 FIRST SEMESTER

Week 5

- Project Plan V1 Created
- Website Created

Week 6

- Requirements gathering
- Updated Project Plan
- ADC Working with lab supplies

Week 7

- Begin working on interfacing ADC with microcontroller

Week 8

- Interface ADC with Microcontroller
- Install OS on Microcontroller

Week 9

- Finish Interfacing ADC with microcontroller
- Install OS on Microcontroller

Week 10

- Get test readings from ECG sensors
- Work on Algorithm for interpretation of ECG
- Install OS on Microcontroller
- Begin creating power system to distribute power

Week 11

- Install OS on Microcontroller
- Start coding algorithm to interpret ECG
- Create power system

Week 12

Code algorithm to interpret ECG

Create power system

Week 13

Code algorithm to interpret ECG

Week 14

Test algorithm with ECG sensors

6.2 SECOND SEMESTER

Week 1

Test and modify algorithm

Start designing PCB

Start designing harness

Week 3

Test and modify algorithm

Design PCB

Design harness

Week 5

Test and modify algorithm

Design PCB

Manufacture harness

Week 7

Receive PCB and put together

Start working on Presentation material

Test and refine harness

Week 9

Work on Presentation material

Test all electronics systems

Test and refine harness

Week 11

Presentation material

Week 13

Present design

7 Conclusions

Our project is to create a system which captures ECG waveforms of a pilot in flight to detect situations where they are at risk of falling unconscious. Our client, Rockwell Collins, has sent us several pieces of hardware, including an ARM M7 microcontroller board and an analog to digital converter (ADC). Our goal is to design a system capable of running continuously for 4-5 hours. The system will use ECG sensors to capture heart stress data, which will go into the ADC and then to our microcontroller. The microcontroller will filter and analysis the data.

8 References

Client: JR Spidell at Rockwell Collins

Faculty Advisor: Dr. Akhilesh Tyagi

ECG Waveform Resources:

https://biomedical-engineering-online.biomedcentral.com/articles/10.1186/s12938-017-0371-6

https://ecglibrary.com/ecghome.php

https://physionet.org/physiotools/software-index.shtml

STM32 MCU Nucleo Microcontroller Resources:

http://www.st.com/en/evaluation-tools/stm32-mcu-nucleo.html?querycriteria=productId=LN1847

http://www.st.com/content/st_com/en/products/evaluation-tools/product-evaluation-tools/mcu-eval-tools/stm32-mcu-eval-tools/stm32-mcu-nucleo/nucleo-f767zi.html

9 Appendices

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. You may also include your Gantt chart over here.