DAQ for Dogs

Design Document

Team 15

Client: Simon Laflamme

Adviser: Simon Laflamme

Co -Team Lead: Yan Jie Hui and Rohan Yadlapati

Communications Lead: Matthew Faronbi

Hardware Lead: Daeyoo Kim

Webmaster: Rishab Kinnerkar

Team Email: sddec18-15@iastate.edu

Team Website: http://sddec18-15.sd.ece.iastate.edu

Revised: 4/13/2018 v.2

Table of Contents

List of Figures

List of Tables

List of Definitions

DAQ: Data Acquisition

1 Introductory Material

1.1 Acknowledgement

Our client, Simon Laflamme, as well as Austin Downey will be our main sources of technical knowledge and funding for this project. Having vast background knowledge on the project and past experience, their input will be vital to the success of this project.

1.2 Problem Statement

Our client is currently developing a biosensor that can be used on live animals to detect strain data on skin. The specific location where the sensor will be placed is on stitches made on dogs. This will allow vets and medical personnel to be able to collect data regarding movements made by the dog and the resulting effect on the stitches.

Our task for this project is develop a data acquisition system that will be able to take the input from the sensor, convert and display the data so that is can be used by vets. Since the sensor will be on the dog, another important aspect of our project is to make our DAQ small enough to also be placed on the dog without causing discomfort. Another goal for this project, is to build an app that can display the data for the purpose of providing a user friendly interface for vets to be able to manage the data.

1.3 Operating Environment

Our DAQ has the versatility to be used with any wired resistance sensor, however for our purpose it will be placed on a dog. For this reason, it will need to be very sturdy. As most pets are very active and reckless at times, we will need to build a case of some sort to house our DAQ to keep the components safe. We were also told by our client that our dog would most likely be wearing a safety cone as well as a harness. This makes our job a little bit simpler as we have a location to store it as well as being able to avoid the dog's mouth from damaging our device. Another feature that we it needs to have it to be able to be resistant against the outdoor environments, such as been able to resist to water and dust.

1.4 Intended Users and Intended Uses (two paragraph +)

The intended users of this project will mainly be veterinarians and our client. The data that we will be recording is the effects of various kinds of movement on stitches. This can be used for medical research on stitches as well as administering more effective stitches.

Our DAQ will have specific use, which is to be operated in dogs to collect data from the strain sensor throughout the day. However, it could be adapted to be use in different environments if the sensor is changed and the program calibrated.

1.5 Assumptions and Limitations

List of assumptions:

- The product will only be used by our client
- The sensor will be provided by the client
- The DAQ only has to collect resistance data from one sensor

List of limitations:

- The overall size and weight must be minimal to not discomfort the dog
- We have been provided a $200 budget for this project.
- The device should have a personalized app
- The DAQ has to have a 16 bit ADC
- Minimum clock speed of 100Hz
- The range of resistance error should be 20%.

1.6 Expected End Product and Other Deliverables

Spring 2018:

DAQ

- Working model on Arduino provided by client:
  - Be able to collect data from sensor.
  - Filter the data.
- Possible second smaller design:
  - Work the same as the first prototype, but smaller design.

DAQ App

- Computer App:
  - User have a safe and reliable way to store and access data.
  - Display Data with different plot options.
  - Warning notification: resistance data is high(damage to stitches)

Fall 2018:

DAQ

- Third and final design:
  - Printed circuit board for the last design.
  - Extra features: on off button, micro Sd card, battery life display, wireless communication(possibly).

DAQ App

- Computer app:
  - Personalize the features to the user liking.
- Mobile app:
  - Develop a mobile app with similar features of the computer app and possible have wireless communication with our DAQ.

2 Proposed Approach and Statement of Work

2.1 Objective of the Task

Through this project we propose to have a functioning DAQ system which is able to collect the stress exerted on the stitches which would be there on dogs. Our system would be a portable data collecting device capable of storing the stitch-stress data on the storage device of a circuit board. Overtime as the dog wound begins to heal we would expect the stress on the wound to reduce. Otherwise, our system would detect anything unexpected and alert the owner. In addition, we would be collecting data which would be used in understanding the how the stitch stress affects the healing process and whether there can be any changes made in the tightness of the stitch while stitching dog wounds.

2.2 Functional Requirements

1) Data acquisition and parsing to circuit board
2) Data storing
3) Computations on the acquired data
4) Parsing data/computed data from circuit board to a computer server
5) Application must the able manage the data
6) Application for non-technical audiences

2.3 Constraints Considerations

Our client has mentioned the following restraints:

1) We need to be collecting data using USB or an SD card
2) The resistance data can have an error upto 20%
3) Our data should be collected with a frequency of 100Hz
4) Each data segment which is collected should be 16bits
5) There needs to be ON/OFF measures
6) It should be small and light to attach to a dog collar.

2.4 Previous Work And Literature

We could not find a product which is similar to the design our client expects us to make. However, in the market there are many DAQ systems which serve different purposes. Fundamentally, we would collect data and do computations as per our client's instructions. The design of the DAQ system is also going to be original. In the market there are DAQ systems for collecting soil humidity, water temperature etc. We would be studying the designs of these DAQ systems to get an understanding of the data acquisition processes deployed in this system. Secondly, we would be making the raw data which is collected readable after performing calculations on it. This would be presented in the form of an application. There exist many applications which similarly perform tasks as the one we propose to have.

2.5 Proposed Design

Our group decided to solve the problem by designing a DAQ that can read and store data from the sensor as well as designing an app to let the user manipulate and visualize the data.

The sensor provided by the client is a titanium oxide trip which changes its resistance if strain is applied on it. In the future, the client will possibly provide a different better sensor.

The DAQ will be base on the Arduino microcontroller, which is a open source. Our design will use the same microchip use on arduino(Atmega328), however our device will only have the minimum components necessary for the DAQ to perform all the required tasks. For the data storage, we are going to use a microSd card, which is a convenient way for the user to save data. One more feature we are going to implement is a wireless module which will be able to send alerts to the user.

The app will be consisted of a website which will be connected to a database in which the user will be able to store the data. The online app will serve as a interface in which the user can also manipulate and plot the data for analysis. A mobile app will also be created, besides giving more versatility to the user, it will also serve as a way for the DAQ wirelessly alert the user of high strain values on the sensor, which can indicate problems which the stitches.

2.6 Technology Considerations

Another possible discussed highly specialized design was to find each component that meets the requirements of our client,such as a FPGA and put it together into a fabricated board.However the design which used the arduino as base for our circuit is more practical, cheaper, easier to program and it can still meet the requirements of our client.

The DAQ we will make is a miniature and low-cost. The system maintains maximum flexibility while remaining as small and lightweight as possible. But, as it is made in small size, it is easy to be broken by active dog's movements. Therefore, we will need to build a casing which can protect the electronics parts of the device from anytype of damage.

2.7 Safety Considerations

As this is an electronic device, we should concern about electric and fire hazards. The purpose of our project is caring dog's health care, therefore we should put a strong emphasis on dog's safety. We need to make sure that the electronic of the device do not interact with the dog in a harmful way. Our device will not produce high amounts of voltage or have high amounts of power dissipation, which will make significantly difficult to influence the dog's health overall.

2.8 Task Approach

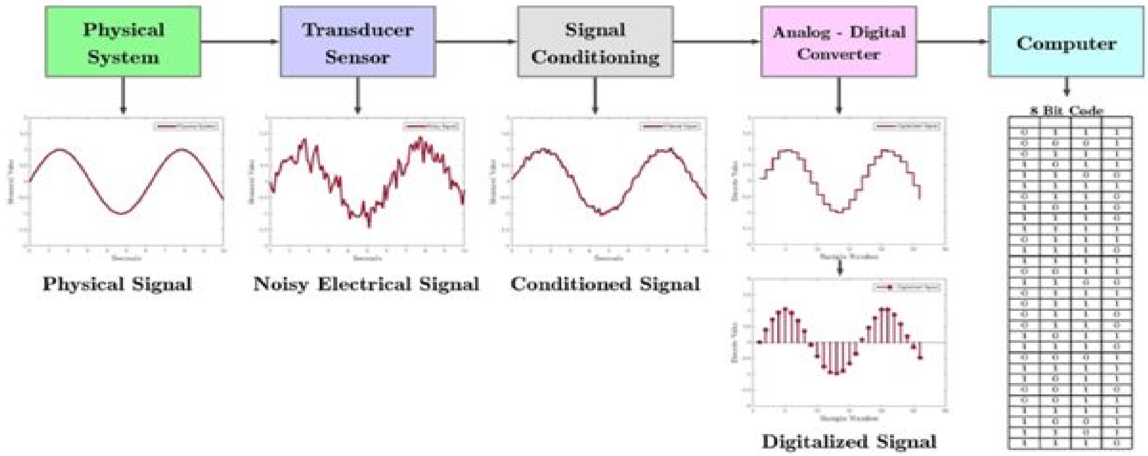

Figure 1.

First of all, we need to deeply understand how DAQ system works. A sensor(transducer) converts physical phenomenon, which is the strain on the dog's skin into a variable resistance. The DAQ is able to measure this change in resistance. DAQ hardware acts as the interface between computer and signals and then it digitizes incoming analog signals. After that, the computer can interpret them. This converting system is called ADC(Analog to Digital Converter). Finally, we install a software for programming to control the operation of the DAQ device. It is used for processing, visualizing, and storing measurement data.

Our approach to perform the tasks described above is to use the Atmega328. This microchip can be programmed by using the arduino IDE, which has a lot of functions and libraries built in. Because arduino is a open source, there are multiple boards on the market that we could use to add the necessary features to our project.

2.9 Possible Risks And Risk Management

Our project is very passive in its effects on animal it is being placed on. While it will add some unwanted weight near a stitched area, it will not affect the animal in any other way. Some concerns we have is the potential increase in cost if our printed board doesn't meet the requirements, our lack of knowledge when it comes to circuit board design, as well as our lack of past experience with data acquisition. We are taking early steps to avoid these issues in the future, however these issues can still arise.

The design that our group decided to follow provides a certain degree of freedom in case we decided to add more features, however because we did not build the circuit from scratch we might have to make future extra modifications on our circuit to be able to add the desired functionalities, which might also affect the overall size of the device, which is our main concern.

2.10 Project Proposed Milestones and Evaluation Criteria

For the Spring semester a milestone that our team and the client agreed on was to have a working DAQ regardless of size that would be able to receive data from the sensor, filter it and display it.

Another small goal is to begin developing an app that would add more functionality to our project. Within the semester some goals we have are to, understand the sensor, learn how to program the arduino, be able to collect data from the sensor using the arduino, filter the data, and to display the data. While these steps seem simple, it will take our team some time to get through each of these steps.

For the Fall semester our goal is to have our product on a board that we designed which will be lightweight and portable. We would also like to having a finished app which will somehow be able to connect to the DAQ. Assuming we have a working prototype going into the fall semester, some goals we have are to design a circuit board to our specifications, be able to transfer all our work onto this new board, run tests to make sure it meets all the requirements, finalize our app as well as its purpose for our project.

2.11 Project Tracking Procedures

We have created a basic timeline, posted in 3.1, that we will follow throughout the semester. We have also set-up weekly meetings as a group and bi-weekly meetings with our client to notify him of our progress. These measures will ensure that we stay on track or at least are aware of our progress of the overall project.

2.12 Expected Results and Validation

Our desired outcome is to have a DAQ built on our own printed circuit board that meets all the requirements provided by the client. We also want to have a working app that will be able to communicate with the DAQ.

2.13 Test Plan

Our project will be divided into 3 design prototypes. To make sure we successfully complete the project, the prototypes need to meet the following requirements:

Prototype 1: Read data from analog input and store in SD card.

- No resting is going to be required in this phase

Prototype 2: The Device should be a smaller version of the first prototype, it should record data within 20% error, it should power efficient. In order to confirm the functionality of our decide the following tests will be performed in this order:

1. Multimeter: Check all voltages and currents are within the safe and recommended limits of our circuit. This step is essential, because we don’t want to have any of our components burned and changed during our resting phase.
2. Static testing platform: Profile the sensor resistance behavior due to strain. We are going to plot resistance vs strain on excel by recording various different point on the multimeter in order to find a mathematical relationship.
3. Oscilloscope: Once we profile the sensor behavior, we will be able to test the accuracy of the collect data by hooking the oscilloscope to our sensor while our device is in use. The data should be with in 20% error compared to the oscilloscope values.
4. Dynamic platform: In the end we would like to perform a dynamic stretching test by using a platform that we would build. This test has the purpose of making sure our device can still record accurate data when high changes of strain values are applied on our sensor,

because the dog will be static at times, but he will also be moving or running at other times, which will make the strain on his skin change dynamically.

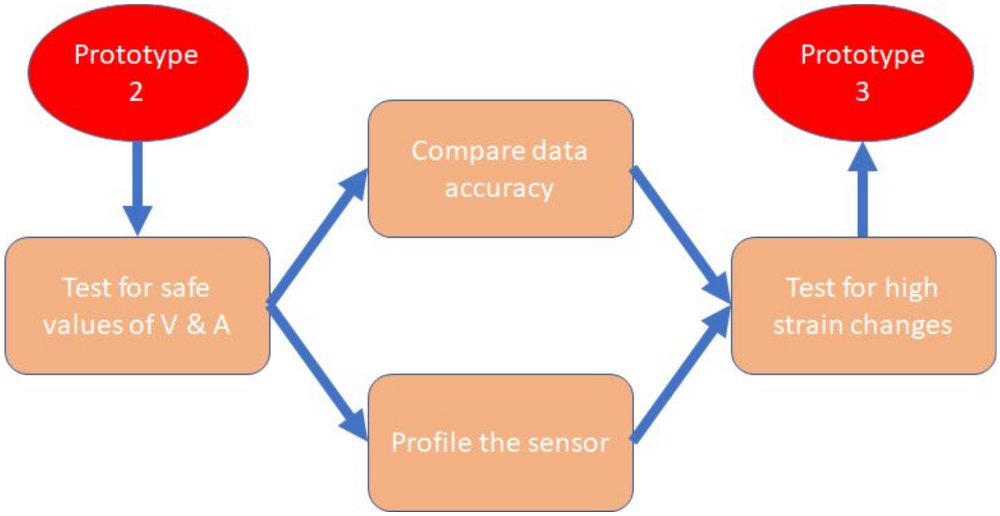

Figure 2. Test plan design 2

Prototype 3:

- In progress

3 Project Timeline, Estimated Resources, and Challenges

3.1 Project Timeline

First Semester	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
1-Microcontroller														
Initial research		■	■											
Initial test				■	■									
Research desing 2									■	■	■			
Plan design 2											■	■		
Build and test desing 2												■	■	
Final test for design 2														■
2-Sensor														
Get familiar with hardware		■												
Initial Test			■											
Research ways to test senor							■	■						
3-Data Collection														
First test						■	■							
Filter & calibrate data design 1											■	■		
Filter & calibrate data design 2													■	■
4-App & Data base														
Set up website & data base							■	■						
Personalize it for user									■	■				
Manage data											■	■		

Table 1. Overview of the semester 1 plan

Second Semester	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
1-Microcontroller														
Research design 3	■	■	■											
Assemble & test design 3			■	■	■									
Decide final features						■	■							
Add final features							■	■	■	■				
Design case										■	■			
Design water proof case											■	■		
Final project test													■	
2-Sensor														
Built harware to test sensor			■	■										
3-Data Collection														
Filter & calibrate data design 3						■								
Filter & calibrate data final 3													■	
4-App & Data base														
Start mobile phone App		■	■	■	■									
Personalize mobile App								■	■	■				
Personalize computer App								■	■	■				
Final Apps test													■	

Table 2. Overview of semester 2 plan.

Our project has 3 major components: The microcontroller, the sensor, the computer and mobile application. Our group decided to approach the project by dividing it into 3 phases with 3 designs which are improved upon the previous one.

Design 1:

1. Design thinking and brainstorming ideas.
2. Obtain Basic understanding of the different parts of the project.
3. Build a initial prototype.
4. Set up the web data-base.
5. Create a online computer app.
6. Reflect on the initial prototype and make improvements on the last model

Design 2:

1. Design a smaller microcontroller.
2. Built and test it.
3. Personalize the computer app.
4. Find a battery to suit our needs.

Design 3:

1. Possibly implement wireless module to send warnings to the user.
2. Design a mobile app.
3. Design and print our own circuit board.
4. Arrange the circuit in a neat way and design a protective casing.
5. Design a dynamic way of testing the final product.

3.2 Feasibility Assessment

We believe that this project is perfectly within reason for this time frame. Given that we have all the resources to test our project currently the success of this project relies on the amount of time spent on the project as well as learning the required material.

We already have an Arduino with built-in data storage, access to software to program the arduino as well as a sensor similar to the final product. We are beginning the testing phase of the arduino given to us to understand more about the hardware and software aspect of this project. With the reasonable timeline we have built, we believe this project can be completed. However, that are a lot of features that we have been discussion on adding to our final design, we plan on implementing as many as we can considering our time and skills limitation. For example, one of ideal features is to send the data wirelessly into our database and have a real time feedback system connected to the users mobile app.

3.3 Personnel Effort Requirements

Include a detailed estimate in the form of a table accompanied by a textual reference and explanation. This estimate shall be done on a task-by-task basis and should be based on the projected effort required to perform the task correctly and not just “X” hours per week for the number of weeks that the task is active

3.4 Other Resource Requirements

For the first prototype the group will use circuit boards and material that can be obtained from the electronic shop on Coover. However, for our final design we want to be able to print circuit board to solder the components of our DAQ. We will also need to add a data storage system onto our board so that the information can be stored and moved onto another platform.

For long term use, we should consider cost effective battery in particular for the Arduino Uno. We should read through the datasheet of the Arduino Uno (Figure 3) and then try to choose battery based on the recommended voltage range on the Arduino. Figure 4 shows an example with 9V battery to operate the device.

3.5 Financial Requirements

For this project, financial requirements will be minimal, all of the hardware required are basic circuits board materials that are fairly inexpensive. The only part that would require some investment would be purchasing a microcontroller, which the group decided on buying an Arduino Board.

4 Closure Materials

4.1 Conclusion

Our end goal for this project is to have developed a small and portable DAQ that will be able to filter and display data received from a biosensor placed on a dog. We must also develop an app with the goal of adding more functionality to our product. We must design a circuit board for our final product to add all the necessary components to make our project more personalized.

4.2 References

Some links:

How to connect the adafruit SD module to an Arduino board:

https://thecavepearlproject.org/2014/07/01/a-10-diy-data-logger-is-born/

Ideas on how to make the smallest "bareduino" possible:

http://forum.arduino.cc/index.php?topic=130806.0

Using Attiny84 as our microchip:

https://harizanov.com/2012/05/toying-with-attiny84-and-sd-card-in-arduino-ide/

How to use Matlab to log data with Arduino:

https://www.mathworks.com/matlabcentral/fileexchange/51710-data-logger-on-arduino-uno

How to build a “bareduino”:

http://tuttle.merc.iastate.edu/eClubs/projects/bareduino.pdf

https://www.farnell.com/datasheets/1682209.pdf

http://www.instructables.com/id/Powering-Arduino-with-a-Battery/

4.3 Appendices

Arduino Uno Datasheet	
Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O pin	40mA
DC Current for 3.3V pin	50mA
Flash Memory	32KB (ATmega328) of which 0.5KB used by bootloader
SRAM	2KB *ATmega328)
CLock Speed	16MHz

Tabel 3. Arduino Uno Specs