UMass Amherst

MDR,
MDR Draft Report
&
Website

November 2018

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5 Lecture 4 MDR, Draft Report & Website	6	7	8	9	10
11	12 Holiday	13	14	15	16	17
18	19 Thanksgiving Recess	20 Thanksgiving Recess	21 Thanksgiving Recess	22 Thanksgiving Recess	23 Thanksgiving Recess	24
25	26 MDR	27 MDR	28 MDR	29 MDR	30 MDR	

December 2018

Sun	Mon	Tue	Wed	Thu	Fri	Sat
2	3 MDR	4 MDR	5 MDR	6 MDR	7 MDR	8
9	10	11	12 Last Day of Classes	13	14	15
16	17	18	19	20 Last Day of Exams Websites due Draft MDR Report due	21	22
23	24	25	26	27	28	29

19 days to MDR

43 days to website & draft report

MDR

26th Nov – 7th Dec

MDR Format

- Team Presentation (30 min)
  - ppt presentation
  - demos of MDR deliverables
    - in conference room
    - in SDP lab (or other)
    - embedded pics and videos

- Evaluators Q&A (20 min)

UMass SDP19 MDR – Evaluation Sheet

Team Members: **Evaluators:**	**Team Number/Name**

Presentation (10%) gpa range (4.0 - 2.0)	❑ (4.0) A professional presentation that demonstrates knowledge and practice. ❑ (3.5) The presentation should have been practiced more. ❑ (3.0) The presentation was confusing at a few points. ❑ (2.5) The presentation was confusing at more than a few points. ❑ (2.0) The presentation was poorly organized or presented.
System Requirements (10%) gpa range (4.0 - 2.0)	❑ (4.0) The system requirements are clear, complete, and appropriate. ❑ (3.5) A few necessary system requirements are missing or unclear. ❑ (3.0) More than a few system requirements are missing. ❑ (2.5) System requirements are given, but they are either inappropriate or very incomplete. ❑ (2.0) Minimal emphasis was placed on system requirements.
System Block Diagram (15%) gpa range (4.0 - 2.0)	❑ (4.0) A plan to accomplish the project is clearly described by a system block diagram including interfaces and feasible plans to implement each block. PDR feedback is fully incorporated. ❑ (3.5) A system block diagram is clearly presented, but one or two blocks are not clearly defined in either its interface or implementation. PDR feedback is only partially incorporated. ❑ (3.0) More than two system-level blocks are missing, either an interface or an implementation. PDR feedback is not incorporated ❑ (2.5) A system block diagram is presented, but it does not describe how the project will be completed. ❑ (2.0) A useful system block diagram was not presented.
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UMass SDP19 MDR – Evaluation (Written Comments) Team Members: Evaluators:	Team Number/Name
Presentation	
System Requirements	
System Block Diagram	
Demonstration of Deliverables	
Team Responsibilities and (2018-19) Schedule	
Other Comments	

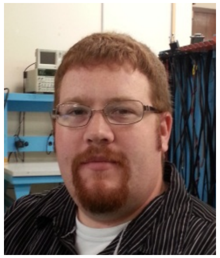
Must Do!

- ~24hr email reminder of day/time/location
- Hard copy handouts of slides (multiple slides/page)
- Separate hard copies of:
    - block diagram
    - MDR deliverables (with individual responsibilities)

Example MDR

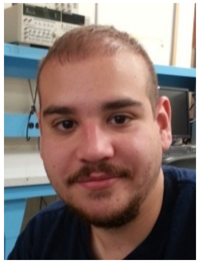
Team RCA
SDP13

RCA (Real-Time Concussion Analyzer)



Timothy Coyle, EE
Impact Processing & Communication

Kenneth Van Tassell, EE
User Interface & Communication



Scott Rosa, CSE
Server & Data Analysis

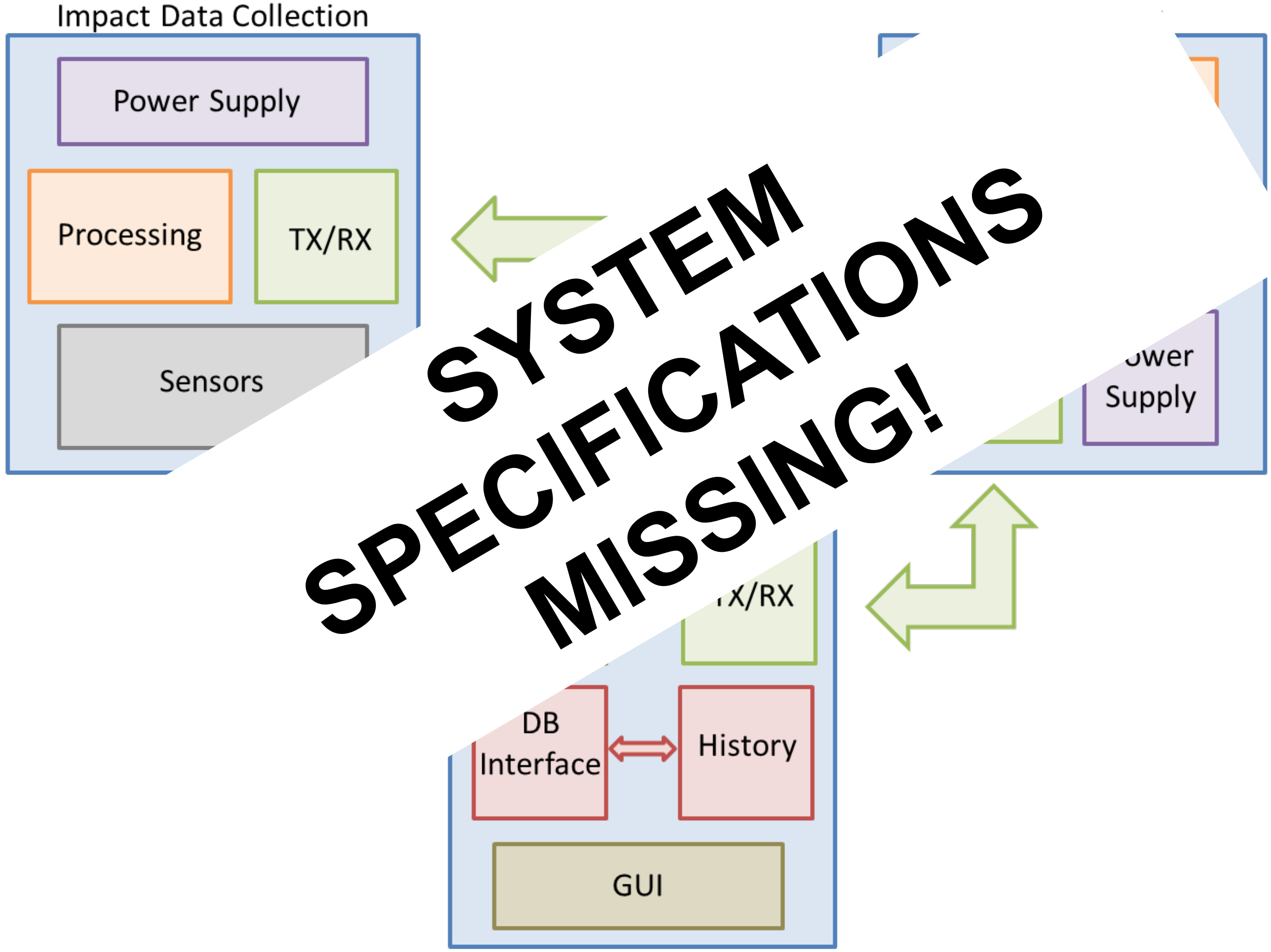
Justin Kober, EE
Sensor Network & Power

Concussion Detection in High School Football

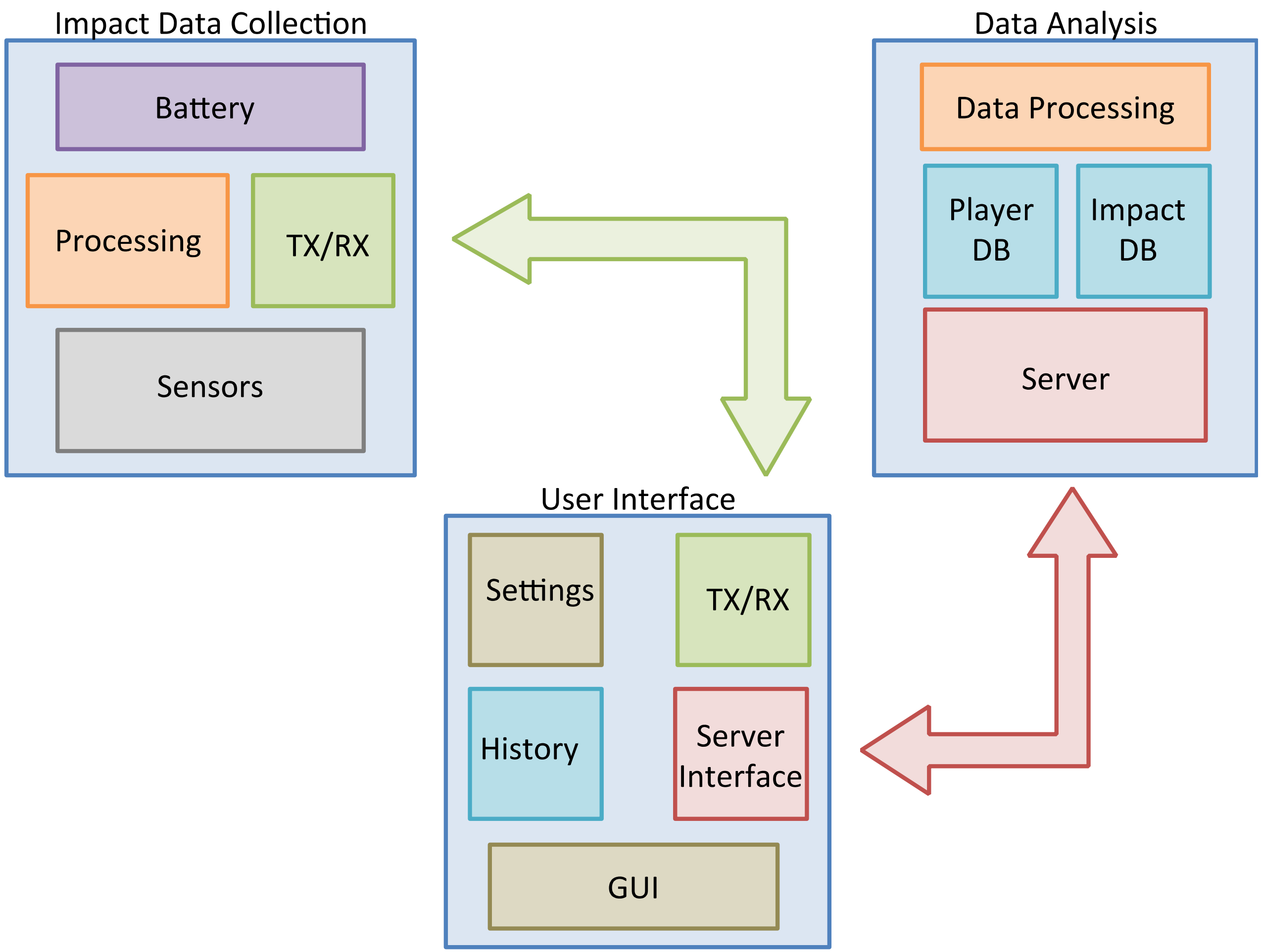
- Current concussion detection
  - Train coaches to recognize symptom
- Players may hide or not … ice symptoms right away
- RCA will m … ach player and alert the coach … risk of concussion after each collision
- Customer feedback
  - College trainers and high school athletic director

PROBLEM STATEMENT!

Our Previous Solution: Block Diagram



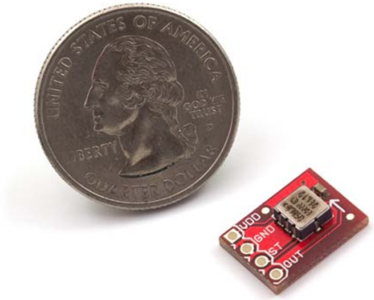
Our Redesigned Solution: Block Diagram

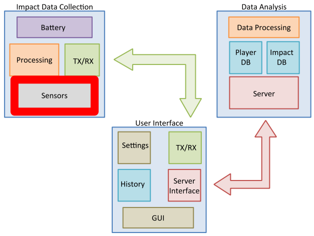


- Bluetooth
- Android
- Server

Sensors

- ADXL 193 MEMS Accelerometer
  - Testing
  - Noise analysis
- PCB Design
  - ADXL 78
  - More sensitive

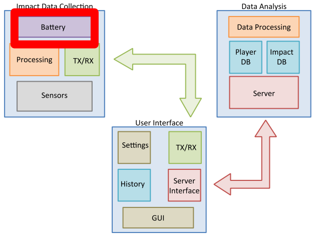




Battery Selection

- Energy Consumption
  - Worst Case: 25.0 kJ per game
  - Typical: 5.8 kJ per game
    - 100 ms per hit and 100 hits per game

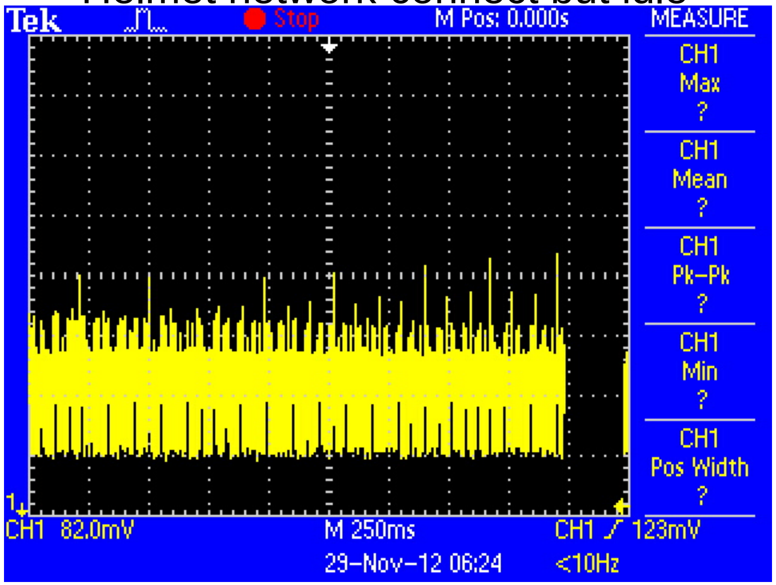
- Coin Cell Batteries
  - Weight & Size
  - Series or Parallel



Measured System Energy Consumption

Helmet network connect but idle

mV

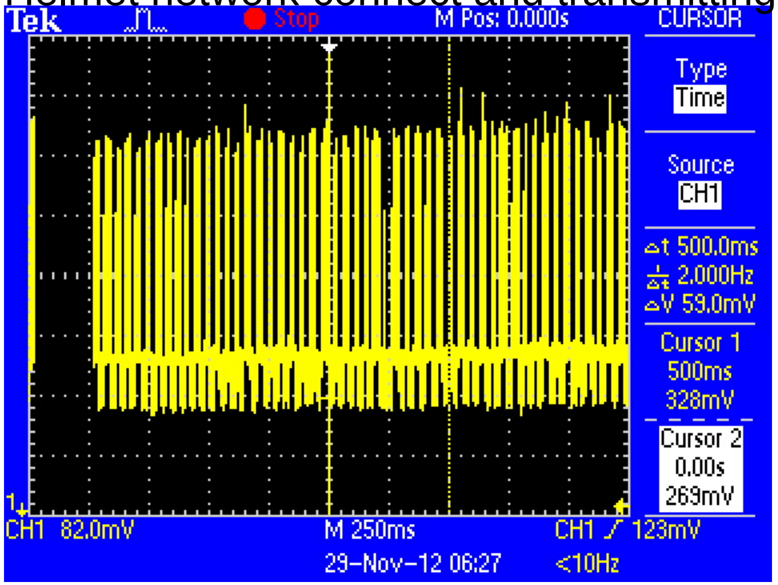


ms

Mean Voltage: 255.8 mV

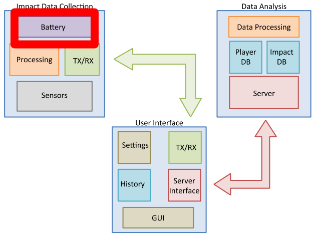
Helmet network connect and transmitting

mV



ms

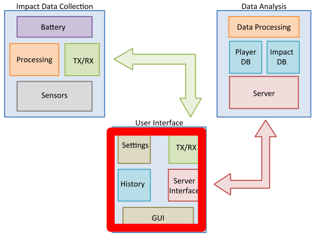
Mean Voltage: 305.6 mV



Application / User Interface and UI Communication

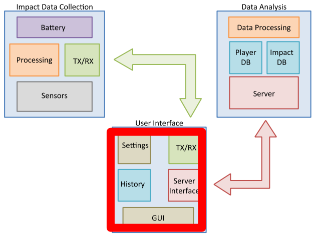
- Requirements
  - Easy to use
  - Displays Acceleration
  - User Adaptable
    - Coach vs. Trainer
  - Reliable

- Challenges
  - Unable to perform long processes on UI thread
  - Uncaught process errors
  - Working with Android Bluetooth protocol



Application / User Interface and UI Communication

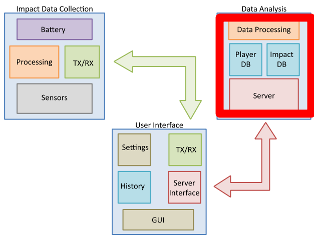
- Android AsyncTask
  - Allows multi-threading in Android applications
  - Performs tasks asynchronously in the background
- Android Debugging
  - Used to catch unseen errors
  - Found and fixed multiple runtime errors
- Android Bluetooth
  - Using Android Bluetooth package
  - Measured response time of transfer to be 16.8 ms



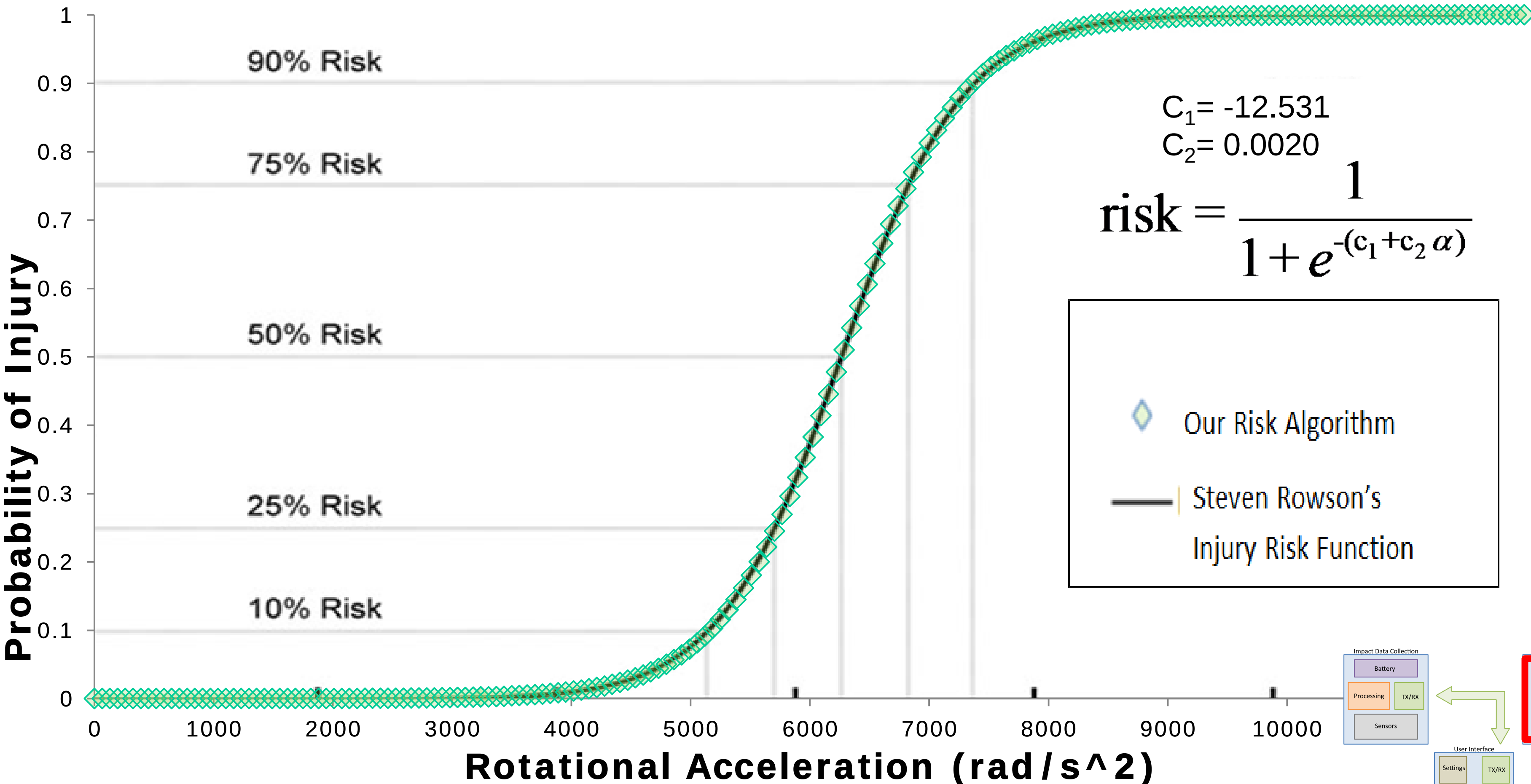
Data Processing and Storage

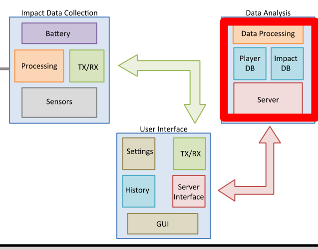
- Requirements
  - Calculates rotational acceleration
  - Determines probability of concussion
  - Output within 500 ms
  - Store all impact data efficiently

- Accomplished
  - Calculates rotational acceleration and probability of concussion in average of 411.6 ms
  - Computational analysis
  - Set up server with database to store data
  - Tested and graphed data



Test Results





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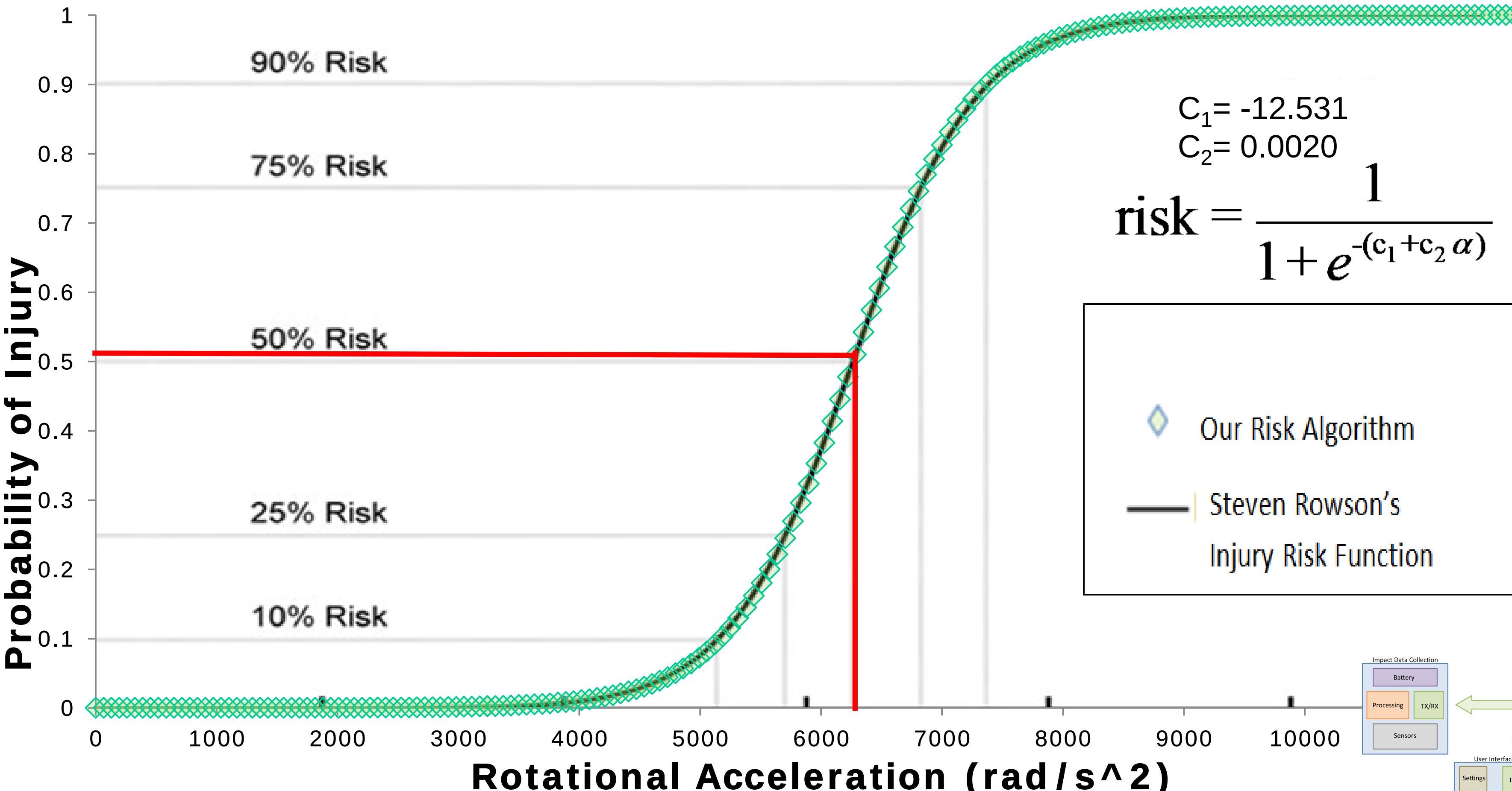
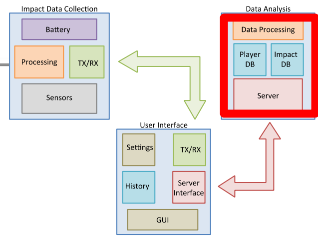


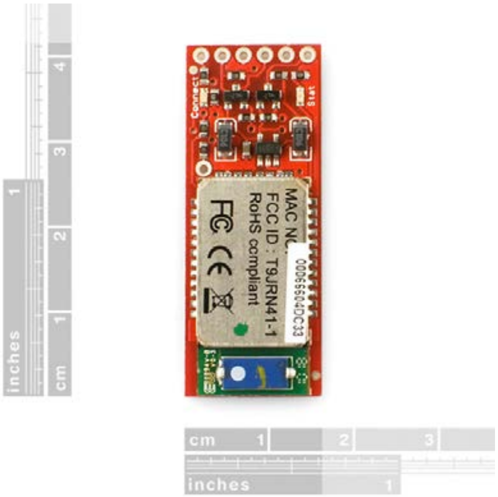
C_1= -12.531
C_2= 0.0020

$$risk = \frac{1}{1 + e^{-(c_1 + c_2 \alpha)}}$$

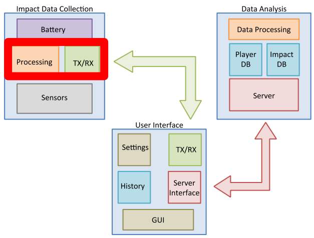


Impact Processing & Communication

- ATmega32U4 8-bit AVR Microcontroller
  - 16MHz Clock
  - 10-bit ADC every 8us



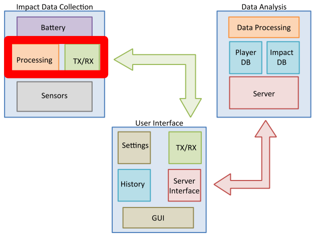
- Bluetooth: BlueSMiRF w/ RN-41
  - Redesigned for scalability
  - 25m Effective range
    - Proof of concept vs. XBee redesign



Impact Processing & Communication Experiments

- Experiments
  - Compared sensor to datasheet
    - Noise in system
  - Sample rate
    - Noise stabilized and found sample rate problem
  - System output vs direct sensor output
    - Confirmed sampling rate problem
  - Revised sample rate settings
    - Improved sampling rate and confirmed stable output

- Statistical analysis
  - Mean, Variance, Histograms
    - Confidence intervals of final system



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Proposed MDR Deliverables

- Demonstration of Impact Data Collection
  - Accelerometer interfaced with processor
  - Helmet processor transmission

- Demonstration of Base Station/UI Interaction
  - Using test data
    - Receive from helmet
    - Run algorithm
  - UI able to receive and display test results

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    - Receive from helmet
    - Run algorithm
  - UI able to receive and display test results

Proposed CDR Deliverables

- Demonstration of Complete System [illegible]onality
  - Show implementation of battery [illegible]ystem
  - Impact the helmet with a kn[illegible]
  - Transmit impact data wit[illegible] sample rate from the sensor array to [illegible]vice
  - Display risk of [illegible] with confidence interval on Android de[illegible]
  - Displa[illegible]pact history on Android device upon us[illegible]

GANNT CHART MISSING!

Thank You

Questions

UMass SDP18 MDR – Evaluation Sheet

Team Members: **Evaluators:**	**Team Number/Name**

Presentation (10%) gpa range (4.0 - 2.0)	❑ (4.0) A professional presentation that demonstrates knowledge and practice. ❑ (3.5) The presentation should have been practiced more. ❑ (3.0) The presentation was confusing at a few points. ❑ (2.5) The presentation was confusing at more than a few points. ❑ (2.0) The presentation was poorly organized or presented.
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De

SDP Report

- draft due: 20th Dec’18
- coordinator feedback: 14th Jan’19
- final due: 4th Feb’19

StarTrack

Rebecca Baturin, EE, Christopher Boyle, CSE, Charles Urbanowski, EE, and Daniel Willmott, EE

***Abstract* — Even despite the banality of everyday life, the splendor of starlight and the space beyond continues to dazzle and inspire people of all kinds of origins. In order to aid the sense of discovery amongst astronomy enthusiasts and photography hobbyists alike, the StarTrack guided mount will allow users to track astronomical objects while maintaining the high standards of quality for a photograph. The system is composed of two joint accessories: a user-interfacing application, and a mount for the user's DSLR camera. The mobile application provides the user access to a database of celestial objects to track and will also be able to wirelessly send tracking directions to the corresponding mount. The mount itself incorporates three powered motors to adjust the exposure angle of the provided camera in order to ensure the celestial object remains in clear focus during the length of several extended exposures. At the conclusion of each session, the user will be presented with several images of their specified object. While the individual images may not be unique on their own, they form a distinctly focused photograph when the images are stacked together.**

I. Introduction

ASTROPHOTOGRAPHY is the term for pictures of space. The night sky contains a multitude of celestial objects unseen to the naked eye even in rural settings. With long exposures of the night sky, it's possible to capture images of stars, constellations, and galaxies. Taking long exposure pictures of moving objects presents an inherent problem: after a 5 minute exposure any light captured will have moved, creating streaks of light instead of sharp images. In order to cancel out the movement of the earth, the camera must rotate at the same rate. This approximation of the Earth's angular rotation proves difficult without a mechanical system to compensate.

The biggest influence in low cost astrophotography, and the most popular tool for newcomers to the field is the barn door mount. First introduced by George Haig in the April 1975 edition of *Sky & Telescope* magazine [1], this mount replaces the mechanical motion of an equatorial mechanical mount with a manual or hand crank system for rotating at the same rate of rotation as the earth. The results, while good, require constant attendance and are frequently much less accurate than expensive solutions due to human error.

The inspiration for automating a barn door mount came from our team member Rebecca Baturin's coworkers during her co-op with NASA at the Kennedy Space Center. Unsurprisingly, many of the engineers there are both hobbyists and amateur astrophotography enthusiasts. Many had built barn door trackers themselves, but were dissatisfied with the quality of the images being produced. Another issue they found with this manual process was the need to be continuously outside with the mosquitos and Florida heat for 45 minutes to take a succession of exposures. They envisioned an automated barn door tracker as portable, easy to use, and above all accurate, and from there StarTrack was born.

Our next step in the research and design phase was to investigate the specifications of currently available mounts. Options for automated mounts are often prohibitively expensive for hobbyists. They are frequently bundled with a telescope, and require advanced knowledge of star coordinates.

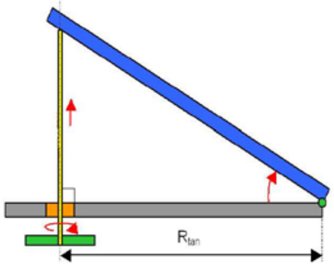


Figure 1: Barndoor Tracker Mount
(http://commons.wikimedia.org/wiki/File:Scotch_mount.png)

Having assessed the options, we came up with a set of goals for the project. The most important factor was clear: automation of as many aspects of the mount as possible is imperative. This accomplishes two of our goals; automation reduces the need for the user to be present for the entire exposure, and reduces the amount of error dramatically.

Additionally, we want a low cost final product. Expenses for cameras and high quality photography can become expensive quickly, and we want to provide comparable results for a fraction of the price of a professional mount.

We also want the final object to be approachable for newcomers. The system should be usable by individuals without much knowledge of the stars, as well as customizable and adaptable for those with prior experience.

R. Baturin from Norwood, MA (email: rbaturin@umass.edu)
C. Boyle from Springfield, MA (email: coboyle@umass.edu)
C. Urbanowski from Pepperell, MA (email: curbanow@umass.edu)
D. Willmott from Weymouth, MA (email: dwillmot@umass.edu)

SDP Report Rules

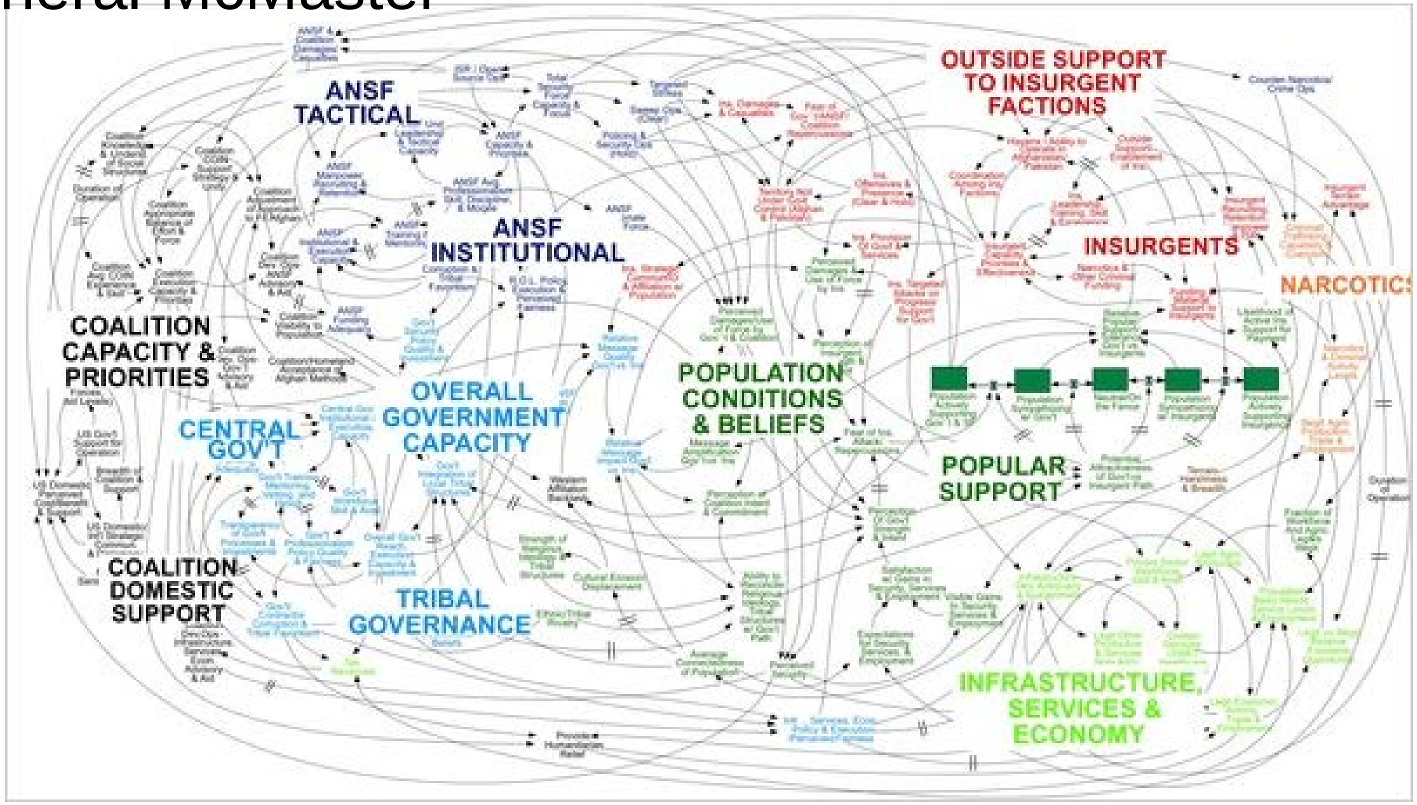
- IEEE Paper Format
- Cite all sources
- Grammar Counts
- Clear
- Content
  - 0. Abstract
  - I. Introduction
  - II. Design
  - III. Project Management
  - IV. Conclusion

Why

"We Have Met The Enemy and He is Powerpoint."
--NY Times Article on Military Powerpoints 2010

Why

- “It is dangerous because it can create the illusion of understanding and the illusion of control.”
  --General McMaster



IEEE Format

Download MDRformat.doc

Preparation of Senior Design Project Report

First A. Author, EE, Second B. Author, CSE, Third C. Author, EE, and Fourth D. Author, CSE

***Abstract*—This is an editable template. You should follow the format of this template in writing your SDP Midyear report. Your abstract that goes here should be one paragraph based on the abstract you wrote earlier.**

I. Introduction

START with the statement of the problem. What is the problem that you are trying to solve? How big is this problem? Include citations that demonstrate that your problem is significant.

Put your problem in to context. How have people solved your problem in the past? Has the problem changed with time? What are the impacts on societal impacts of your problem? How does your problem effect individuals?

Summarize the requirements analysis that you performed. How big can your solution be? How much power can it use? How will someone use your solution? List the specifications in a Table as shown in Table 1.

TABLE I
SPECIFICATIONS

Specification	Value
Weight	<10kg
Height	<10cm
Length	<5cm
Width	<10cm
Battery Life	>5 hours

experiment you will perform to design or test this block. Explain how you will analyze the results of this test.

D. Block 3

Describe what this technical block will do. Explain what technology you will use to build this block. Detail which techniques from courses you will use to build this block. List what you need to learn in able to build this block. Explain an experiment you will perform to design or test this block. Explain how you will analyze the results of this test.

Cite All Sources

- You Can Site a Web Page
  - Don’t just type the URL
- Even if you didn’t have to look it up you should cite it.
- Describe what the cited work did and what you added to it.

Grammar Counts

- Use complete sentences.
- Check your spelling.
- Avoid comma splices.
- Proofread, proofread, proofread.

Write Clearly

- Strunk and White said: “Write Tight”
- Start with an outline
- Start over

SDP Report Content

- Aside & Context (ABET)

- Content
  - I. Introduction
  - II. Design
  - III. Project Management
  - IV. Conclusion

ABET

- Accrediting Board for Engineering Degrees
- UMass EE and CSE programs evaluated every 6 years

ABET Student Outcomes (a-k)

a) an ability to apply knowledge of mathematics, science, and engineering.

b) an ability to design and conduct experiments, as well as to analyze and interpret data.

c) an ability to design a system, component, or process, to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d) an ability to function on multidisciplinary teams.

ABET Student Outcomes

e) an ability to identify, formulate, and solve engineering problems.

f) an understanding of professional and ethical responsibility.

g) an ability to communicate effectively.

h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

i) a recognition of the need for, and an ability to engage in life-long learning.

ABET Student Outcomes

j) a knowledge of contemporary issues.

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

SDP Report Content

I. Introduction
II. Design
III. Project Management
IV. Conclusion

I. Introduction

- State the problem (e)
- How big is the problem (needs citation)
- How have people solved this problem? (c)
- What impact(s) does your problem have on individuals, society, and the environment? (c) (f)(h) (j)
- System specifications table (e)

Specification Table

TABLE I

SPECIFICATIONS

Warning!

Do Not Use This Table Verbatim

Specification	
Weight	[illegible] ms)
Range	
Response Time	
Battery Life	
Cost	[illegible] full team of 52 players
Power Consumpti	
Acceleration Range	+/- 70 g
Sensitivity	Only measure actual collisions
Durable Packaging	Stable and waterproof

II. Design

- Overview (Block Diagram) (e)(f)
- Block 1
  - What will it do? (c)
  - What technology will you use to build it? (a) (i) (k)
  - How will you test it? (b)

III. Project Management

- Table of MDR Deliverables
  - What have you done
  - What is left to do
- What is each member’s expertise? (d)
- How do you help each other? (d)
- How does your team communicate? (d)(g)

IV. Conclusion

- What is the current state of the project?
- What are you working on now?

Sample MDR Report

SDP19 Team websites

Up and running - no later than Thursday 20th Dec'18

Minimal content
- Team pics
- Problem Statement
- System Specifications
- Block Diagram
- PDR/MDR slide decks
- Draft report

SDP Team website examples

Team 16 - Viano

Home | Downloads | About | Contact

Viano

The Viano, or virtual piano, allows music enthusiasts to play and record via GarageBand on the go without the hassle of having to carry a full-size midi keyboard around. The Viano is a portable, two-octave, life-size projected keyboard that gives the user the most optimal playing ability and alleviates the struggles of trying to play/record on too small of keys, which is unlike other portable alternatives.

November 2017						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
		31 Benchside Meetings	1	2 Benchside Meetings	3	4
5	6	7	8	9	10	11
12	13	14	15	16 Lecture 3	17	18
19	20 Thanksgiving Recess	21 Thanksgiving Recess	22 Thanksgiving Recess	23 Thanksgiving	24 Thanksgiving Recess	25
26	27 MDR	28 MDR	29 MDR	30 MDR	1 MDR	2

11 days to MDR

December 2017						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
3	4 MDR	5 MDR	6 MDR	7 MDR	8 MDR	9
10	11 Websites due	12 Last day of classes	13	14	15	16
17	18	19	20 Last day of exams Draft report due	21	22	23
24	25	26	27	28	29	30

25 days to website

34 days to draft report

Another MDR Slide Deck

Mid-year Design Review

Team 5: Helping Hand

Team Members: Corey Ruderman, Dan Travis, Jacob Wyner, Joshua Girard

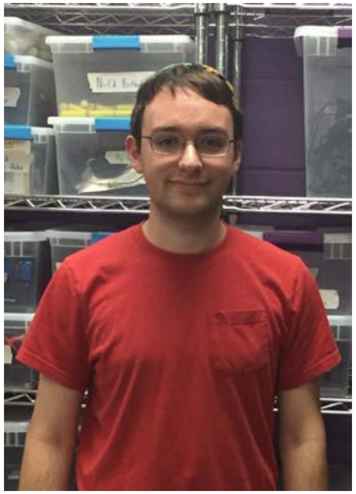
Advisor: Professor Duarte

The Team:

Corey Ruderman
CSE

Daniel Travis
CSE

Jacob Wyner
CSE



Joshua Girard
CSE, CS

The Problem:

- Robotic arms are used in everything from medical research to construction

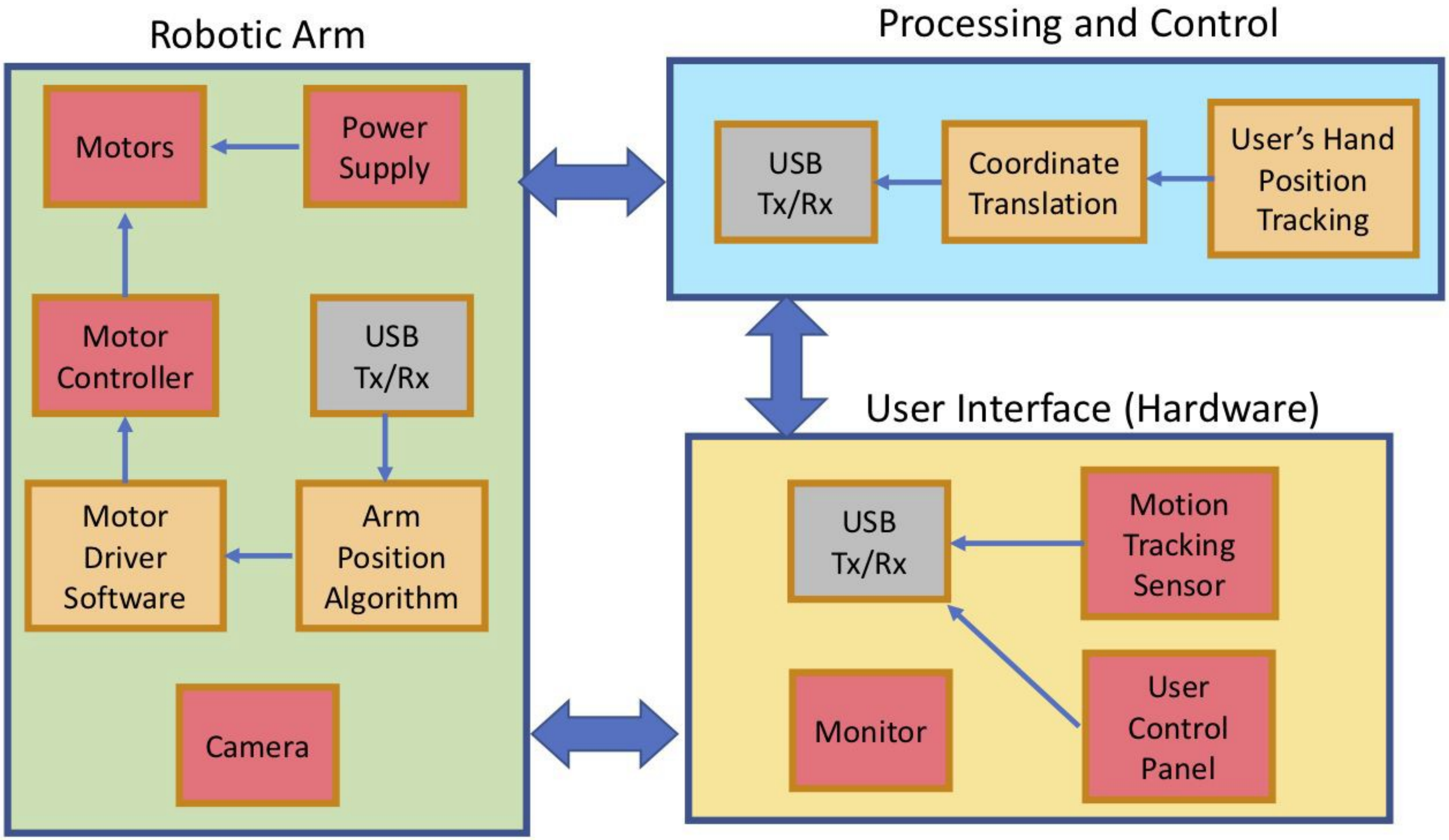
- Remote control of robotic arms is complicated and unintuitive

Arm Requirements and Specifications

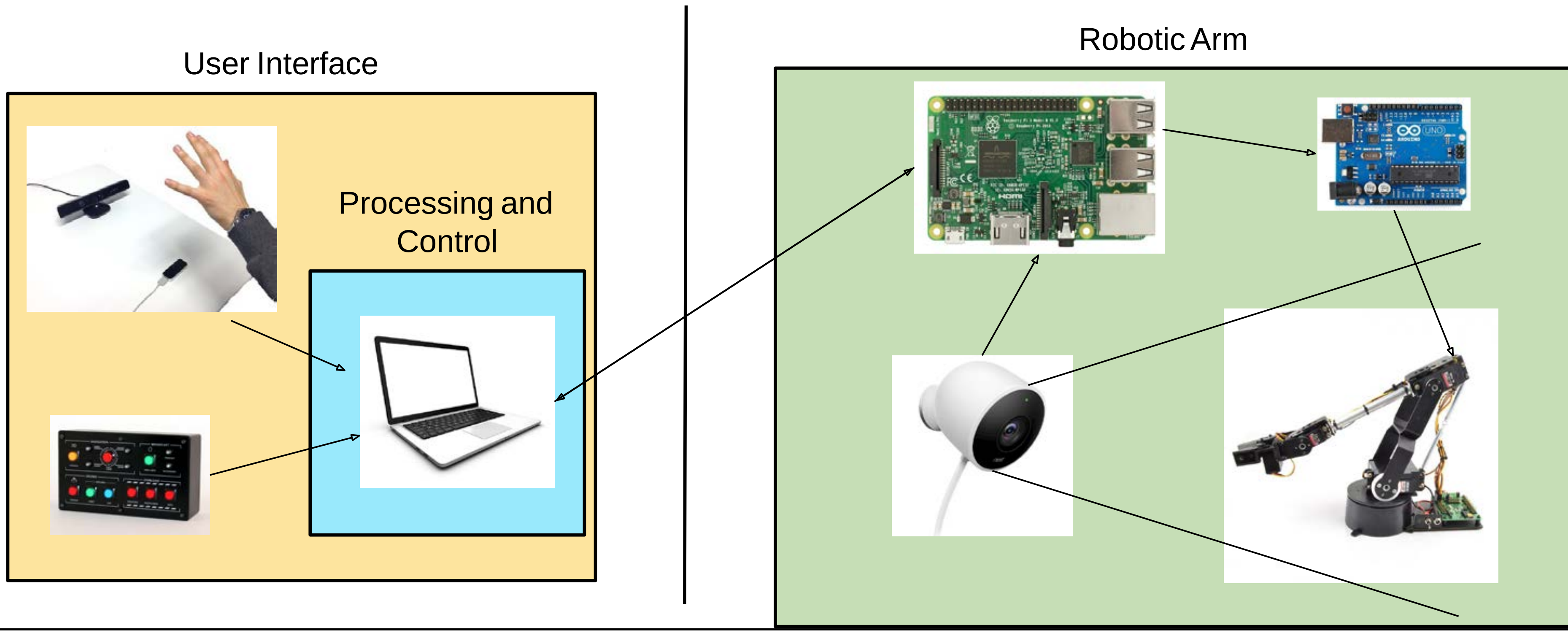
- Arm will have a minimum range of motion defined by a rectangular prism 1.5’x1.5’ horizontally and 1’ vertically directly in front of the robot in 4 DOF
- Arm should mimic the user’s arm position with <0.25 second latency
- Arm will be able to move at least 5 inches per second in any direction
- Robot will move towards the user’s current hand position as fast as possible rather than mimic all movements exactly
- Evaluation metric: Arm will perform the task of moving 5 rocks (approx. size of a ping pong ball) placed randomly within the workspace of the arm into a ~3” tall bowl of diameter ~8” within 5 min

User Interface Requirements and Specifications

- Hand tracking -- Intuitive and easy to use
- Fast tracking rate (>20 FPS)
- Accurate tracking (within 1” of actual hand position)
- Adequate range of motion (> 2’x2’x1’ tracking area)
- User Control Board should implement: on/off, emergency stop, pause/resume


Robotic Arm
Motors
Power Supply
Motor Controller
USB Tx/Rx
Motor Driver Software
Arm Position Algorithm
Camera
Processing and Control
USB Tx/Rx
Coordinate Translation
User's Hand Position Tracking
User Interface (Hardware)
USB Tx/Rx
Motion Tracking Sensor
Monitor
User Control Panel

System Topology



MDR Deliverables

- Arm movement in 3 DOF (base + shoulder + elbow) (Jacob + Dan)
- Arm's vertical movement controlled by integration of all major systems (All)
- Raw user input data is successfully received and processed (Joshua)
- User control board prototype complete (Dan)

MDR Deliverables

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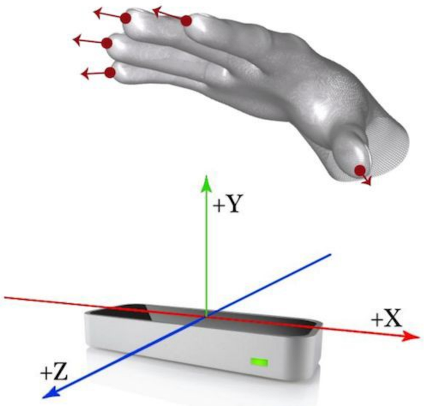
Motion Tracking: Joshua

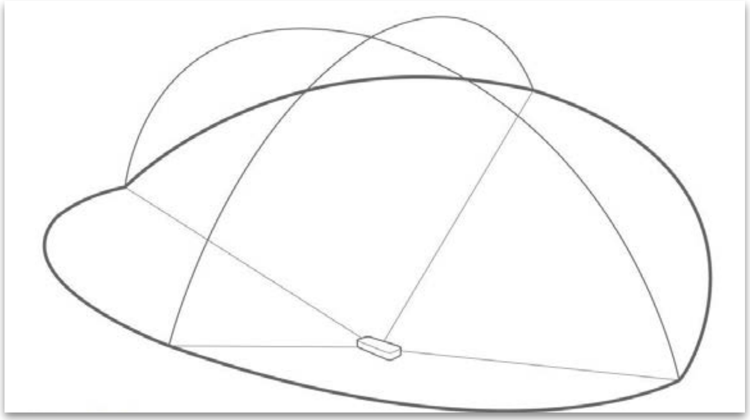
- Leap Motion Controller sensor
  - Effective range: 25 to 600 millimeters above the device (1 inch to 2 feet)
  - Field of view: ~150 degrees
- Mapping of user-space to robot-space coordinates
  - 1.07 : 1 ratio
- Tracking speed
  - ~100 FPS
  - Every 5 samples averaged
  - Transmitting latest coordinates to Raspberry Pi every 50 milliseconds (20x per second)



Design Specification: >20 FPS tracking ✓

Leap Motion Tracking Area

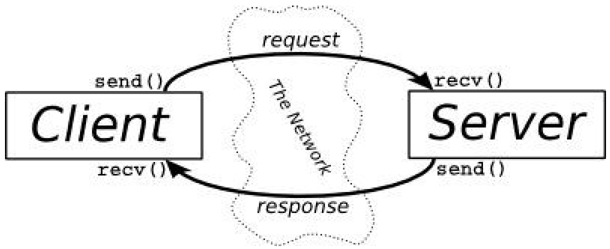
- Tracking Area
  - 2 feet above controller
  - 2 feet wide on each side (150º angle)
  - 2 feet deep on each side (120º angle)



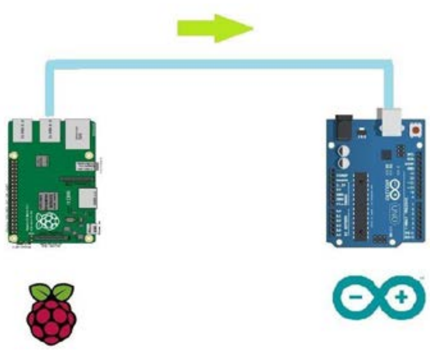
- Design Specification:
  - > 2’x2’x1’ tracking area
  - Tracking area of Leap Motion is not a prism so corners are not within the tracked area
- Exploring Kinect tracking in Spring

Intersystem Communication

- Computer to Raspberry Pi
  - Ethernet: 100 Mbps
  - Client Server Model and TCP protocol

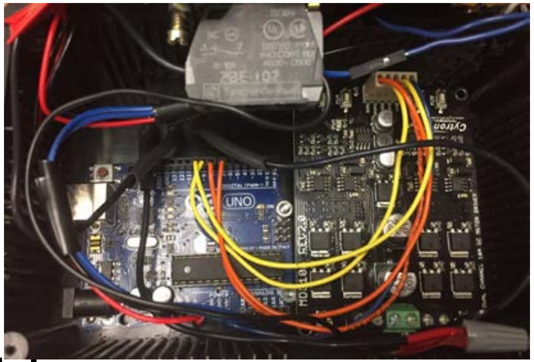


- Raspberry Pi to Microcontroller
  - Serial UART: 9600 bps



Arm Electronic Hardware: Jacob

- Raspberry Pi Model 3
  - Connected to Arduino Uno via Serial UART connection
- Atmega328P microcontroller
  - Controls motor controller using PWM signals
- MDD10A NMOS Dual Channel H-bridge
  - Supports 5V-30V
  - Max continuous current: 10A
  - Peak current: 30A
- Feedback sensors feed into 15-pin VGA cable
- Enclosure contains microcontroller, H-bridge, emergency stop



Arm Control Algorithms: Corey and Jacob

- 2 DOF inverse kinematics algorithm
  - Options: algebraic, iterative, inverse Jacobian
  - We chose to use algebraic method
  - Specific equation is from CS545 at USC

$$l = \sqrt{x^2 + y^2}$$

$$l_2^2 = l_1^2 + l^2 - 2 l_1 l \cos\gamma$$

$$\Rightarrow \gamma = \arccos\left(\frac{l^2 + l_1^2 - l_2^2}{2 l_1 l}\right)$$

$$\frac{y}{x} = \tan\varepsilon \quad \Rightarrow \quad \theta_1 = \arctan\frac{y}{x} - \gamma$$

$$\theta_2 = \arctan\left(\frac{y - l_1 \sin\theta}{x - l_1 \cos\theta_1}\right) - \theta_1$$

- Mapping algorithm
  - Angle is input, sensor value is output so that arm can move to that point in it's linear workspace
  - Calibrated using min/max position of arm

Physical Arm Construction: Dan

- Implemented arm design v1:
  - Used 8020 aluminum frame
  - Two linear actuators
  - One DC motor with gearbox
  - Chain drive for base rotation
  - Wooden Enclosure and base

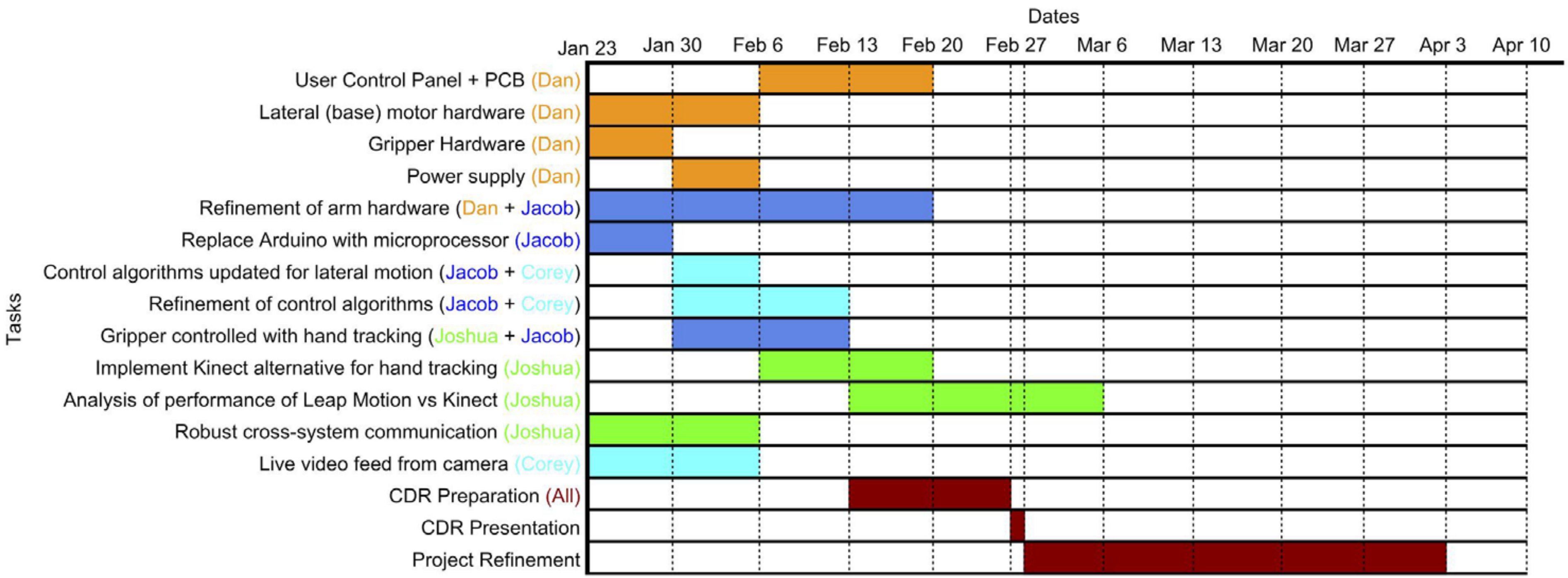
User Control Panel PCB: Dan

- Simple interface to give more control options to the user
- Power On/Off
- Emergency Stop
- Pause and Resume motion of the arm
- Will add additional functionality as needed
- Interfaces with the Raspberry Pi via serial

Proposed: CDR deliverables

- Integration of base motor into control algorithms to provide positioning in 3DOF
- Integration of gripper into system: Gripper state (open/closed) will be controlled by the user opening and closing their hand
- Implementation of live video feed from arm to user allowing them to use the arm remotely
- Arm will perform task as described in specifications slide within the 5 min timeframe

Gantt chart


Dates
Jan 23
Jan 30
Feb 6
Feb 13
Feb 20
Feb 27
Mar 6
Mar 13
Mar 20
Mar 27
Apr 3
Apr 10
Tasks
User Control Panel + PCB (Dan)
Lateral (base) motor hardware (Dan)
Gripper Hardware (Dan)
Power supply (Dan)
Refinement of arm hardware (Dan + Jacob)
Replace Arduino with microprocessor (Jacob)
Control algorithms updated for lateral motion (Jacob + Corey)
Refinement of control algorithms (Jacob + Corey)
Gripper controlled with hand tracking (Joshua + Jacob)
Implement Kinect alternative for hand tracking (Joshua)
Analysis of performance of Leap Motion vs Kinect (Joshua)
Robust cross-system communication (Joshua)
Live video feed from camera (Corey)
CDR Preparation (All)
CDR Presentation
Project Refinement

UMassAmherst

Demo

Thank You

Questions