**Multidisciplinary Senior Design**

**Project Readiness Package**

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|---|---|
| **Project Title:** | Light Rail |
| **Project Number:** (assigned by MSD) | 17316 |
| **Primary Customer:** (provide name, phone number, and email) | XTREMESIGHT<br>Dr. Fred Edmunds<br>Tel: 585.880.4818<br>Email: drfred@xtremesight.com<br>Website: www.xtremesight.com |
| **Sponsor(s):** (provide name, phone number, email, and amount of support) | XTREMESIGHT<br>Dr. Fred Edmunds<br>Tel: 585.880.4818<br>Email: drfred@xtremesight.com<br>Website: www.xtremesight.com |
| **Preferred Start Term:** | Fall 2016 |
| **Faculty Champion:** (provide name and email) | Dr. Vincent J. Amuso<br>vjaeee1@rit.edu |
| **Other Support:** | |
| **Project Guide:** (assigned by MSD) | |

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|---|---|
| Dr. Vincent J. Amuso | 7/15/2016 |
| Prepared By | Date |
| Received By | Date |

Items marked with a * are required, and items marked with a † are preferred if available, but we can work with the proposer on these.

## Project Information

- **Overview:**

The Light Rail is a flexible [fixed] track that uses a series of lights to simulate the motion of a target such as a baseball, tennis ball, or hockey puck. This allows measurement and training of anticipation timing and speed estimation. The user activates a hand controller or swings a bat, a racquet, a hand etc. when the light reaches a certain position on the Light Rail; the controller will then freeze the movement of the lights and display the reaction/anticipation time with an accuracy of one millisecond; the error in distance can be determined by observing which light remains on. The location of the stopped light indicates the instant that the "batter" reacted. The Light Rail controller then displays the early or late reaction time in thousandths of a second (milliseconds).

One of the applications of the unit is to test the area of human visual acuity related to eye-hand coordination and anticipation. The subject is instructed to watch a light as it travels down the runway. They must anticipate the light reaching the target and press a pushbutton, or perform some other action, to coincide with the arrival of the light at the target.

*** Preliminary Customer Requirements (CR):**

- Different start and ending speeds may be set for acceleration or deceleration
- Storage of all test settings
- Any light on the runway can be selected as a target light
- Independent blinking of any light or section of lights along the runway
- Stand-alone instrument with small portable control panel
- Constructed for a wide range of user response methods - handheld push button, photocell, switch mat, or various custom applications
- Portable
- Tablet controller/actuator – tablet or integrated
- Programmable or pre-programmed settings
- Feedback
- Light position and/or digital readout

- Data capture/memory or not
- Hard-wired or wireless (possibly Buetooth) control
- Remote or hard-wired reaction controller

* **Preliminary Engineering Requirements (ER)**:
**Metrics:**

- The trainee ("batter") is positioned so that the last light lines up with him/her and is called "home plate." The first light is 15 to 20 feet from "home plate" simulating the "pitcher's mound."

- When the start button is depressed, the first light (pitcher's mound) will flash on and off.

- After a short time delay (TBD), the lights will appear to move toward "home plate" at a pre-set speed calibrated in miles per hour.

- The "batter" must respond by stopping the moving lights at the same instant +/- 1 millisecond they pass over the "home plate".

**Specifications:**
TBD

* **Constraints**

A working proto type must be complete by February 28, 2017.

* **Project Deliverables:**
Minimum requirements:
- All design documents (e.g., concepts, analysis, detailed drawings/schematics, BOM, test results)
- working prototype
- technical paper
- poster
- All teams finishing during the spring term are expected to participate in ImagineRIT

Additional required deliverables:
- User's Manual

† **Budget Information:**
Include total budget, any major cost items anticipated, and any special purchasing requirements from the sponsor(s).

- Total material cost should not exceed $350.00

* **Intellectual Property:**
Xtreme intends to retain the IP.

## Project Resources

† **Required Resources (besides student staffing):**
Describe the resources necessary for successful project completion. When the resource is secured, the responsible person should initial and date to acknowledge that they have agreed to provide this support. We assume that all teams with ME/ISE students will have access to the ME Machine Shop and all teams with EE students will have access to the EE Senior Design Lab, so it is not necessary to list these. Limit this list to specialized expertise, space, equipment, and materials.

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|---|---|
| **Faculty** list individuals and their area of expertise (people who can provide specialized knowledge unique to your project, e.g., faculty you will need to consult for more than a basic technical question during office hours) | **Initial/ date** |
| Vincent J. Amuso<br>Mr. Tim Landschoot<br>Marcos Esterman | |
| **Environment** (e.g., a specific lab with specialized equipment/facilities, space for very large or oily/greasy projects, space for projects that generate airborne debris or hazardous gases, specific electrical requirements such as 3-phase power) | **Initial/ date** |
| *A lab space where the Light Rail can be tested. Since the rail may be 20 feet long and a subject may be swinging a baseball, an adequate amount of space will be required.* | |
| **Equipment** (specific computing, test, measurement, or construction equipment that the team will need to borrow, e.g., CMM, SEM, ) | **Initial/ date** |
| *Access to the ME machine shop.* | |
| **Materials** (materials that will be consumed during the course of the project, e.g., test samples from customer, specialized raw material for construction, chemicals that must be purchased and stored) | **Initial/ date** |
| | |
| **Other** | **Initial/ date** |
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† **Anticipated Staffing By Discipline:**
Indicate the requested staffing for each discipline, along with a brief explanation of the associated activities. "Other" includes students from any department on campus besides those explicitly listed. For example, we have done projects with students from Industrial Design, Business, Software Engineering, Civil Engineering Technology, and Information Technology. **If you have recruited students to work on this project (including student-initiated projects), include their names here.**

| Dept. | # Req. | Expected Activities |
|---|---|---|
| BME | 0 | |
| CE | 1 | Microcontroller/DSP selection & programming |
| EE | 2 (3*) | Circuit design & construction, component selection, hardware/software interface. (*If possible addition of a third EE with wireless experience.) |
| ISE | 1 | Ergonomics related to subject use and portability & storage |
| ME | 2 | Rail design & construction, stand design & construction |
| Other | | |

* **Skills Checklist:**
Indicate the skills or knowledge that will be needed by students working on this project. Please use the following scale of importance:
1 = must have
2 = helpful, but not essential
3 = either a very small part of the project, or relates to a "bonus" feature
blank = not applicable to this project

Biomedical Engineering

| | BME Core Knowledge | | BME Elective Knowledge |
|---|---|---|---|
| | Matlab | | Medical image processing |
| | Aseptic lab techniques | | COMSOL software modeling |
| | Gel electrophoresis | | Medical visualization software |
| | Linear signal analysis and processing | | Biomaterial testing/evaluation |
| | Fluid mechanics | | Tissue culture |
| | Biomaterials | | Advanced microscopy |
| | Labview | | Microfluidic device fabrication and measurement |
| | Simulation (Simulink) | | Other (specify) |
| | System physiology | | |
| | Biosystems process analysis (mass, energy balance) | | |
| | Cell culture | | |
| | Computer-based data acquisition | | |
| | Probability & statistics | | |

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| | Numerical & statistical analysis | | |
| | Biomechanics | | |
| | Design of biomedical devices | | |

Computer Engineering

| | **CE Core Knowledge** | | **CE Elective Knowledge** |
|---|---|---|---|
| | Digital design (including HDL and FPGA) | | Networking & network protocols |
| | Software for microcontrollers (including Linux and Windows) | | Wireless networks |
| | Device programming (Assembly, C) | | Robotics (guidance, navigation, vision, machine learning, control) |
| | Programming: Python, Java, C++ | | Concurrent and embedded software |
| | Basic analog design | | Embedded and real-time systems |
| | Scientific computing (including C and Matlab) | | Digital image processing |
| | Signal processing | | Computer vision |
| | Interfacing transducers and actuators to microcontrollers | | Network security |
| | | | Other (specify) |

Electrical Engineering

| | **EE Core Knowledge** | | **EE Elective Knowledge** |
|---|---|---|---|
| | Circuit Design (AC/DC converters, regulators, amplifies, analog filter design, FPGA logic design, sensor bias/support circuitry) | | Digital filter design and implementation |
| | Power systems: selection, analysis, power budget | | Digital signal processing |
| | System analysis: frequency analysis (Fourier, Laplace), stability, PID controllers, modulation schemes, VCO's & mixers, ADC selection | | Microcontroller selection/application |
| | Circuit build, test, debug (scope, DMM, function generator | | Wireless: communication protocol, component selection |
| | Board layout | | Antenna selection (simple design) |
| | Matlab | | Communication system front end design |
| | PSpice | | Algorithm design/simulation |
| | Programming: C, Assembly | | Embedded software design/implementation |
| | Electromagnetics: shielding, interference | | Other (specify) |

Industrial & Systems Engineering

| | **ISE Core Knowledge** | | **ISE Elective Knowledge** |
|---|---|---|---|
| | Statistical analysis of data: regression | | Design of Experiment |
| | Materials science | | Systems design – product/process design |
| | Materials processing, machining lab | | Data analysis, data mining |
| | Facilities planning: layout, mat'l handling | | Manufacturing engineering |
| | Production systems design: cycle time, throughput, assembly line design, manufacturing process design | | DFx: manufacturing, assembly, environment, sustainability |

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|---|---|---|---|
| | Ergonomics: interface of people and equipment (procedures, training, maintenance) | | Rapid prototyping |
| | Math modeling: OR (linear programming, simulation) | | Safety engineering |
| | Project management | | Other (specify) |
| | Engineering economy: Return on Investment | | |
| | Quality tools: SPC | | |
| | Production control: scheduling | | |
| | Shop floor IE: methods, time studies | | |
| | Computer tools: Excel, Access, AutoCAD | | |
| | Programming (C++) | | |

Mechanical Engineering

| | **ME Core Knowledge** | | **ME Elective Knowledge** |
|---|---|---|---|
| | 3D CAD | | Finite element analysis |
| | Matlab programming | | Heat transfer |
| | Basic machining | | Modeling of electromechanical & fluid systems |
| | 2D stress analysis | | Fatigue and static failure criteria |
| | 2D static/dynamic analysis | | Machine elements |
| | Thermodynamics | | Aerodynamics |
| | Fluid dynamics (CV) | | Computational fluid dynamics |
| | LabView | | Biomaterials |
| | Statistics | | Vibrations |
| | Materials selection | | IC Engines |
| | | | GD&T |
| | | | Linear Controls |
| | | | Composites |
| | | | Robotics |
| | | | Other (specify) |