

**MULTIDISCIPLINARY SENIOR DESIGN PROJECT**  
**GE 497**  
**COLLEGE OF ENGINEERING**  
**VALPARAISO UNIVERSITY**  
**VALPARAISO, INDIANA**

**System Design Requirements**  
**for**  
**Vertigo-Imbalance Detector**

**Balance of Forces**  
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Revisions (initials in columns indicate approval of revision)						
Letter	Date	Revisor	Advisor	Customer	Team Leader	Reason for Revision
A	9/11	ARH			ARH	Initial draft
B	9/12	ARH			ARH	Advisor suggestions
C	10/16	DLM			ARH	Graded feedback
D	11/26	ARH			ARH	Final SDRD Submission
E						
F						
G						
H						

**Honor Code Statement**

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11/29/2018

I have neither given or received, nor have I tolerated other's use of unauthorized aid.

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Alex Helander

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Nicholas Kwiecinski

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Isaac Lane

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David Mackey

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**Problem Definition**

The balance assistance device will detect a user's vertigo-induced imbalance during daily activities and provide sufficient indication to assist the user in regaining stability.

**Objectives**

In order to achieve success the system shall

1. Measure the general dynamics of the user's body during daily activities
2. Detect conditions where user approaches a balance threshold
3. Provide notification when the user approaches a state of imbalance
4. Be nonintrusive and lightweight on the user's body
5. Be safe and easy to operate
6. Sustain operation effectively throughout a typical day

**System Requirements****1. BALANCE MEASUREMENT REQUIREMENTS**

- 1.1 The device will be able to run a calibration program to determine the user's optimal balance point accounting for the individual's standard stance, weight height, and shoe size.
- 1.2 The device will monitor the angular velocity of pitch in the user's center of gravity within 10 degrees per 50 milliseconds.
- 1.3 The device will monitor the force exerted by the user's feet up to 225 kilogram within 10 kilogram.
- 1.4 The device will monitor the acceleration of the user's center of gravity about the center of their feet position within 10 degrees per second-squared.

**2. IMBALANCE DETECTION REQUIREMENTS**

- 2.1 The device's detection software shall determine when the acceleration of the optimal balance point approaches a calibrated acceleration threshold.
- 2.2 The device's detection software shall determine when the angular velocity of the optimal balance point approach a calibrated angular velocity threshold.
- 2.3 The device's detection software shall detect in real-time if optimal balance point approaches the limits of the user's frame of balance by comparing the real time angle to the critical angle of tipping.

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## 3. INDICATION REQUIREMENTS

- 3.1 The device shall provide a 50 dB to 70 dB audio alert to the user when an imbalance is detected.
- 3.2 The device will shall produce a 10 lumen to 80 lumen visual alert to the user when a battery is drained and needs to be charged.
- 3.3 The device will trigger indicated alerts 500 milliseconds prior to the user's calibrated center of mass exceeding the limits of the user's frame of balance.

## 4. SIZE AND WEIGHT REQUIREMENTS

- 4.1 Each of node of the device will each weigh less than 2 kilograms when attached to the user.
- 4.2 The total weight of the entire system will weigh less than 6 kilogram.
- 4.3 The device components will each be less than 0.2 cubic meters in volume.
- 4.4 The wires between device components shall be less than 50 cm.

## 5. SAFETY REQUIREMENTS

- 5.1 The device shall operate at a temperature less than 20 degrees Celsius.
- 5.2 In a normal operating state, the device shall generate less than 70 dB noise within a 1 meter radius.

## 6. ENDURANCE REQUIREMENTS

- 6.1 The device shall operate at full capacity for more than 6 hours after a full battery charge.
- 6.2 The device shall be able to charge through a standard USB port.
- 6.3 The device or each node of the device will be able to withstand a pressure of 300 kPa to all sides of the device.
- 6.4 Each node of the device shall shift less than 5 centimeters on the user during daily physical motions.