

RaDistance Safety Meter

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Client: Dr. John G. Webster,

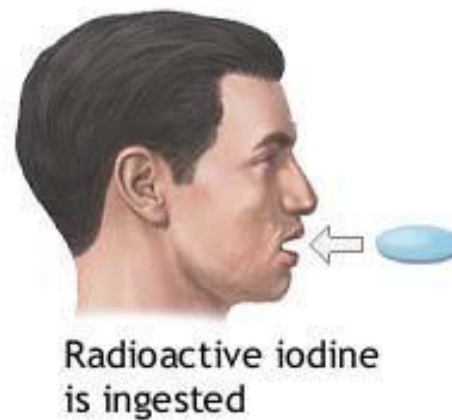
Department of Biomedical Engineering

Client: Dr. Sarah Hagi, King Abdulaziz University

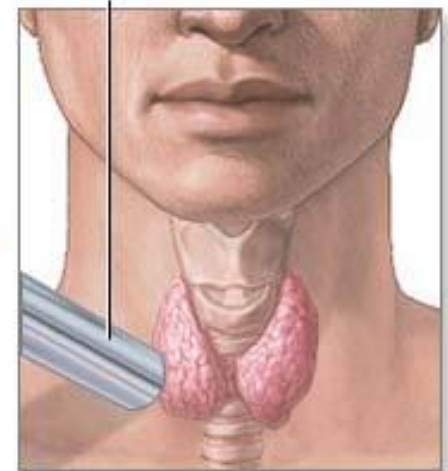
Advisor: Dr. Kris Saha, Department of Biomedical Engineering

Overview

- ▶ Problem Statement
- ▶ Background
- ▶ Product Design Specifications
- ▶ Design Ideas
- ▶ Design Matrix
- ▶ Final Design
- ▶ Future Work



Gamma probe measuring thyroid gland radioactivity



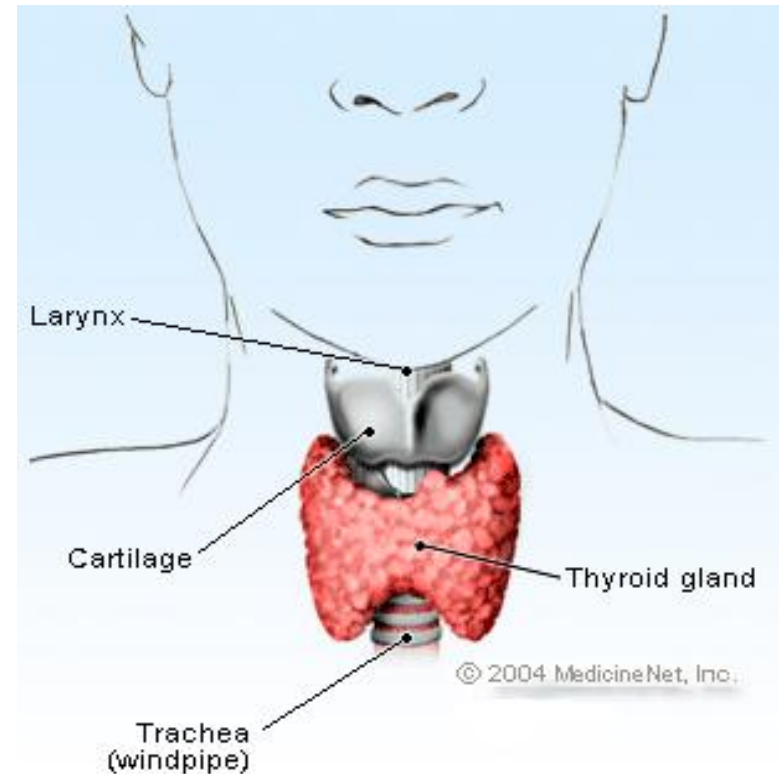
<http://sjccfthynet.blogspot.com/>

Problem Statement

- ▶ Radioiodine (I-131) is harmful to people in close proximity to the patients
 - Radiation exposure should not exceed 5 mSv¹
- ▶ Need device to warn patient when they are within 1 m of another human

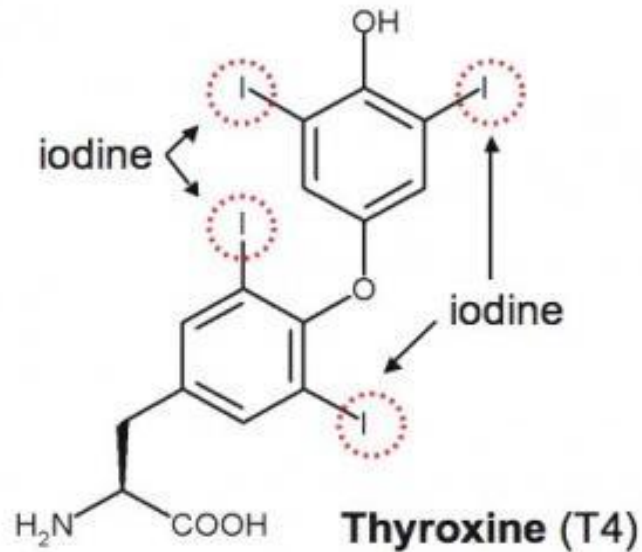
Thyroid Disorders

- ▶ ~200 million thyroid disorders worldwide²
 - 7x more likely to present in women²
- ▶ Medical practice
 - Hyperthyroidism
 - Cancer & nodules
 - Goiter (enlargement)
- ▶ I-131 therapy
 - Radioiodine absorbed by thyroid
- ▶ Timespan of 4–6 weeks³



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Radioiodine (Iodine-131)

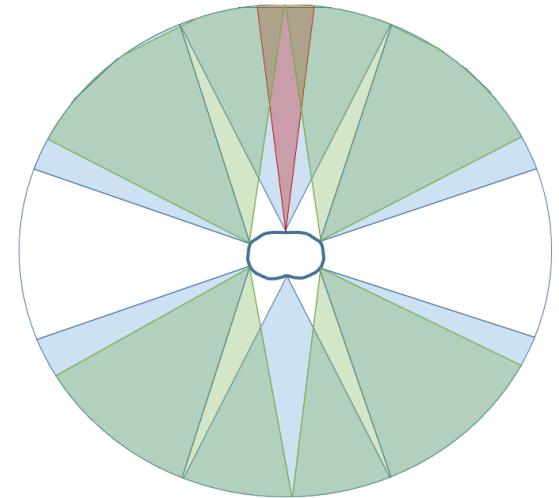


embryology.med.unsw.edu.au

- ▶ Half-life of 8.02 days⁴
- ▶ Radiation type
 - Beta particles
 - Gamma particles
- ▶ Secondhand exposure
 - Ingestion through breathing, food products, and water consumption

Product Design Specifications

- ▶ Detect humans within 1 m radius
 - Accuracy restraint of < 10 cm
- ▶ 360° view from patient
 - Competing design's view = 15°
- ▶ Alert patient of distance breach
 - Auditory, physical, or visual signal
- ▶ Less than 0.5 kg
- ▶ Battery life lasting waking hours
 - ~ 16 h



Competing field of view

Proposed thermal sensor
field of view

Proposed distance sensor
field of view

Design 1 (Placement): Head Band

▶ Materials

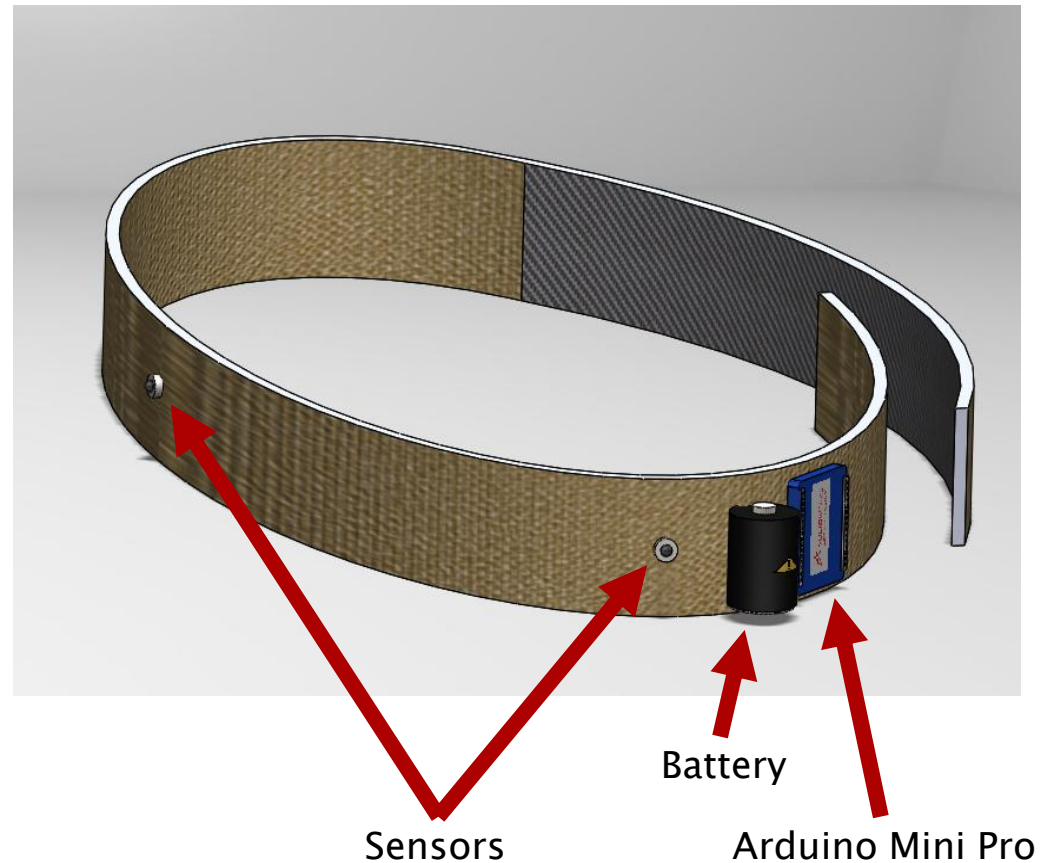
- Polyester fabric
- Velcro attachment
- Estimated cost
 - \$235

▶ Advantages

- No body obstruction
- Adjustable size

▶ Disadvantages

- Uncomfortable after long periods
- Height variations



Design 2 (Placement): Neck Warmer

▶ Materials

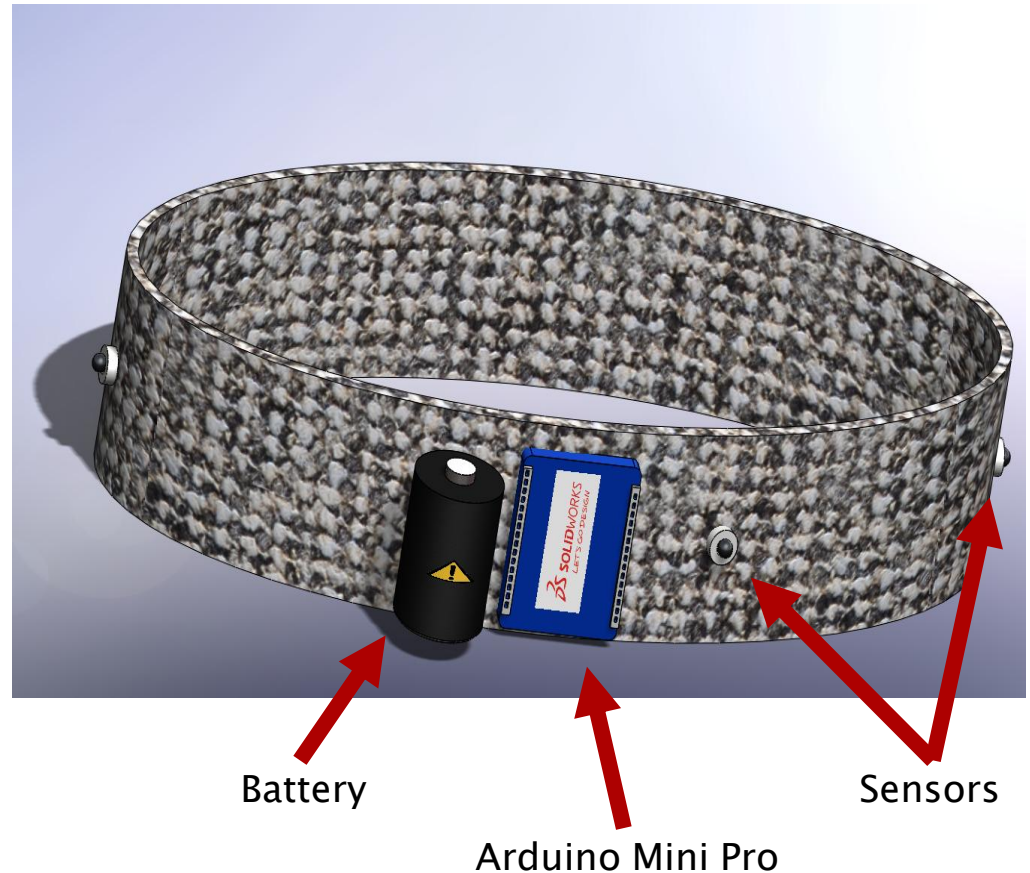
- Wool
- Estimated cost
 - \$235

▶ Advantages

- No limb obstruction
- Easy to fabricate

▶ Disadvantages

- Uncomfortable after long periods
- Height variations



Design 3 (Placement): Shoulder Pad

▶ Materials

- Polyurethane fabric
- Polyester threads
- Velcro
- Estimated cost
 - \$295

▶ Advantages

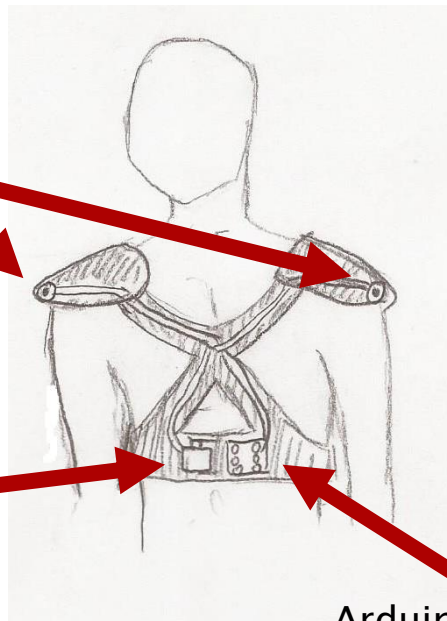
- Secure placement
- No limb obstruction

▶ Disadvantages

- Bulky and heavy
- Size limitations
- Difficult to fabricate

Sensors

Battery



Arduino Mini Pro

Design 4 (Placement): Belt

▶ Materials

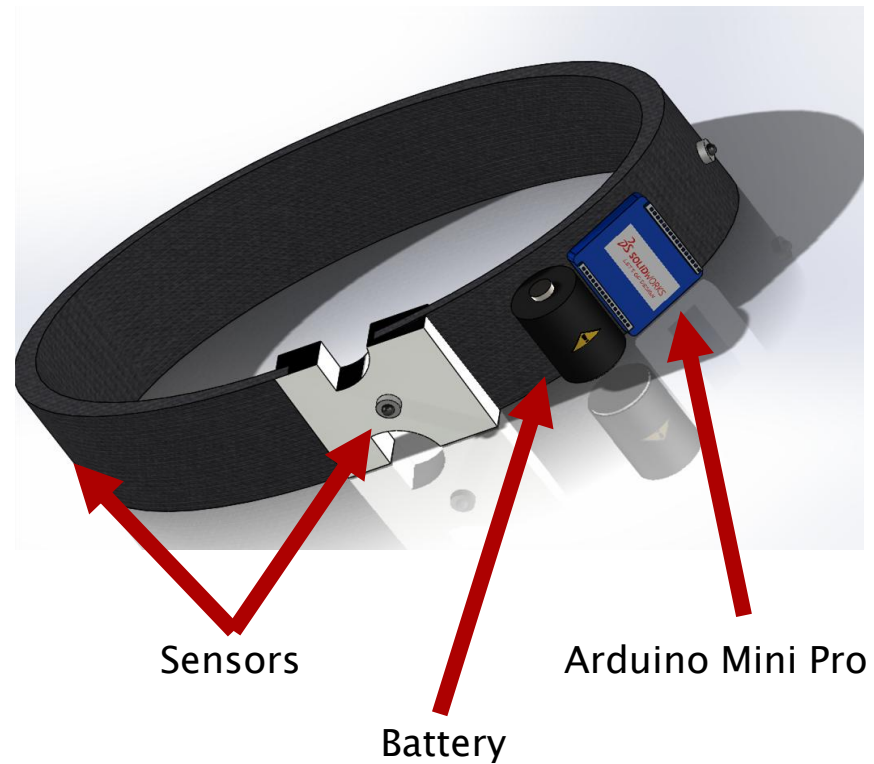
- Webbed nylon (6.5 cm by 1 m)
- Estimated cost
 - \$270

▶ Advantages

- Easy to wear
- Comfortable

▶ Disadvantages

- Obstruction caused by arms
- Higher material costs



Design Matrix (Placement)

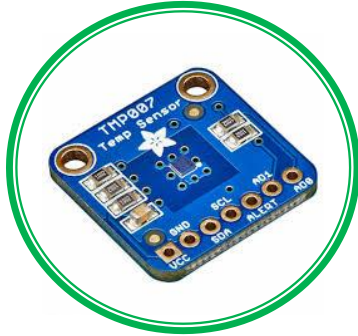
Criteria (Weight)	Head Band		Neck Warmer		Shoulder Pad		Belt	
Fabrication (20)	4/5	16	2/5	8	1/5	4	5/5	20
Cost (10)	4/5	8	4/5	8	2/5	4	3/5	6
Aesthetics (15)	3/5	9	3/5	9	3/5	9	4/5	12
Safety (10)	3/5	6	3/5	6	4/5	8	4/5	8
Accessibility (20)	3/5	12	4/5	16	4/5	16	5/5	20
Comfort/Ergonomics (25)	3/5	15	2/5	10	5/5	25	5/5	25
Total		66		57		66		91

Distance Sensors



- ▶ MaxBotix MB1000 LV-MaxSonar-EZ0
 - \$28
 - 60° field of view
 - Reports distance of nearest object
 - 6.45 m
 - 2.54 cm resolution

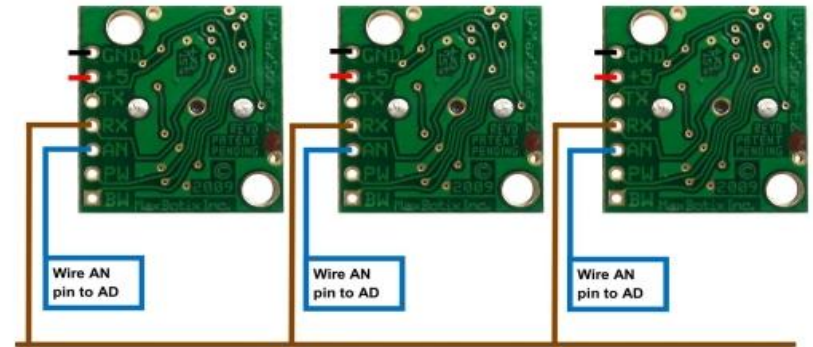
Thermal Sensors



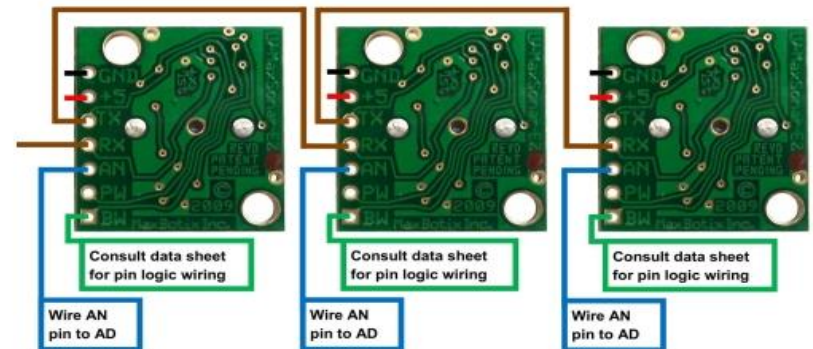
- ▶ Texas Instrument TMP007
 - \$12.50
 - 90° field of view
 - Records average temperature over area
 - 0° to 60° C

Future Work – Fabrication

- ▶ Component attachment to belt
- ▶ Wiring
 - Snake formation
- ▶ Ultrasonic sensor timing
- ▶ Field of view testing
- ▶ Battery testing
 - 2000 mAh battery theoretically sufficient

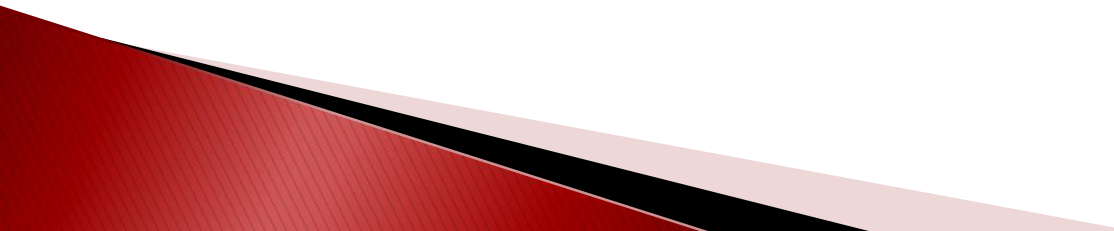


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Acknowledgements

- ▶ Client: Dr. John G. Webster, Department of Biomedical Engineering
 - ▶ Client: Dr. Sarah Hagi, King Abdulaziz University
 - ▶ Advisor: Dr. Kris Saha, Department of Biomedical Engineering
 - ▶ BME Faculty: Dr. John Puccinelli, Department of Biomedical Engineering
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References

1. Barrington, Sally F., et al. "Radiation exposure of the families of outpatients treated with radioiodine (iodine-131) for hyperthyroidism." *European journal of nuclear medicine* 26.7 (1999): 686-692.
2. "Thyroid Disease: Know the Facts." *Awareness, Support, Research*. Thyroid Foundation of Canada, 30 Jan. 2015. Web. 19 Feb. 2015.
3. Ross, Douglas S. "Radioiodine Therapy for Hyperthyroidism." *New England Journal of Medicine* 364.6 (2011): 542-50. Print.
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5. Gilbert, Ethel S., et al. "Thyroid Cancer Rates and 131i Doses from Nevada Atmospheric Nuclear Bomb Tests: An Update." *Radiation Research* 173.5 (2010): 659-64. Print.