

System Design of a Knee Motion Sensor to Prevent ACL Injuries

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Play harder.
Play longer.
You kneed it.



Context Analysis

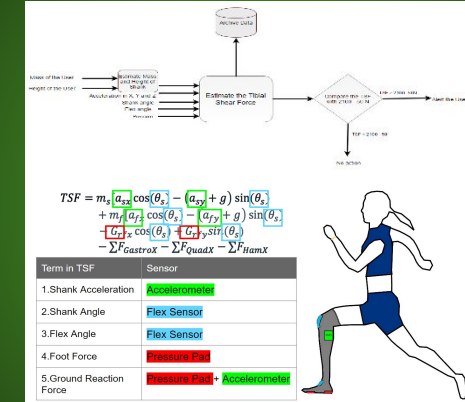
- ACL is short for the Anterior Cruciate Ligament.
- 1 out of every 13 NCAA female athlete sustains an ACL injury.
- ACL injuries do not heal on their own.
- ACL reconstructive surgery can cost up to \$50,000.

Need Statement

There is a need for a system that provides **situational awareness** for athletes in a **game environment** by:

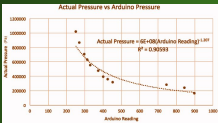
- Estimating the strain applied to the ACL in game situations
- Alerting the athlete when a motion they have performed causes a strain that exceeds 2100+-50N

Functional Description



Testing

Pressure Pads



Weight (lb)	Arduino Pressure	Calculator Pressure (Pa)	Actual Pressure (Pa)	Percent Error
75	747.50	28864.87	27913.28	20.36%
90	427.81	48016.83	39143.23	18.96%
120	375.96	48784.81	48810.88	0.12%
160	316.51	58000.09	62426.51	7.07%
180	299.46	61642.77	70226.47	12.82%
220	272.75	68770.29	88836.02	19.79%
260	252.26	75728.75	92449.00	21.01%

Average Error: 14.5%

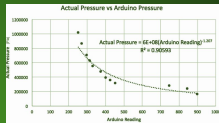
Flex Sensors



Gyrometer	Arduino	Arduino	Percent Error
100.00	100.00	100.00	0.00%
100.00	101.00	100.00	1.00%
100.00	102.00	100.00	2.00%
100.00	103.00	100.00	3.00%
100.00	104.00	100.00	4.00%
100.00	105.00	100.00	5.00%
100.00	106.00	100.00	6.00%
100.00	107.00	100.00	7.00%
100.00	108.00	100.00	8.00%
100.00	109.00	100.00	9.00%
100.00	110.00	100.00	10.00%

Average Error: 5.5%

Accelerometer



Actual Pressure	Arduino Pressure	Arduino Pressure	Percent Error
10000	10000	10000	0.00%
10000	10100	10000	1.00%
10000	10200	10000	2.00%
10000	10300	10000	3.00%
10000	10400	10000	4.00%
10000	10500	10000	5.00%
10000	10600	10000	6.00%
10000	10700	10000	7.00%
10000	10800	10000	8.00%
10000	10900	10000	9.00%
10000	11000	10000	10.00%

Average Error: 5.5%

Results and Conclusion

The Knee Motion Sensor (KMS) device has been shown to reduce the risk of sustaining an ACL injury. The KMS device will alert the athlete of an elevated risk and provide them with situational awareness to help mitigate the probability of an ACL injury.



Future Work

- Miniaturize Electronics
- Conductive Thread
- Incorporate Muscle Forces
- Extensive Testing
- Perform field testing
 - Testing KMS device on GMU athletes
 - Distributing surveys