The Transformation of Blood-Gas Monitors

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The Problem

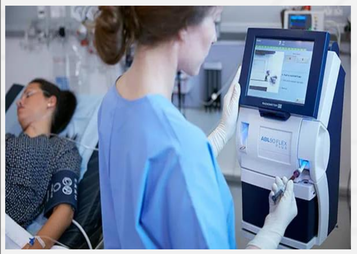
- Respiratory diseases account for **6%** of the global disease burden and are the **third leading cause of death** globally, responsible for **4 million deaths and 454.6 million cases**.[1]
- Wearable blood-gas sensors are vital for monitoring patients and keeping them healthy, however, films inside them yield varying results due to aging and part to part variation.

The Importance of Blood-Oxygen Sensors

The Integrated Circuits and Systems lab at WPI is developing a wearable device that is able to assess PaO_2 and reveal valuable insights on a patient's health.

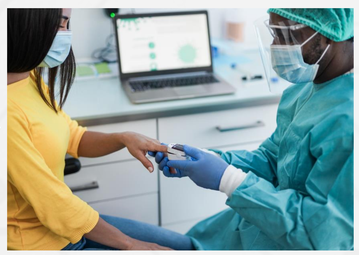
Advantages over traditional methods

- Non-invasive → Less painful
- Wearable → Patients can receive care outside hospital setting.
- Wireless → Continuous monitoring
- Accurate diagnosis → Early notification of potential issues



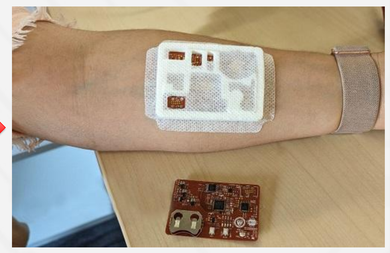
Traditional Blood Sampling

- Invasive
- Highly selective
- Requires professional



Pulse Oximeters

- Non-invasive
- Measures SPO_2
- Nonlinear correlation between SPO_2 and $PtcO_2$



Transcutaneous Blood Gas Monitor[2]

- Non-invasive
- Continuous monitoring
- Does not require professional

My Project's Aim: Find a way to calibrate films for the Blood-Oxygen Sensor.

UN Sustainable Development Goal

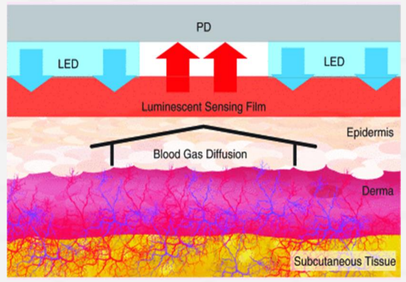
Ensure healthy lives and promote well-being for all at all ages

Classroom Connection

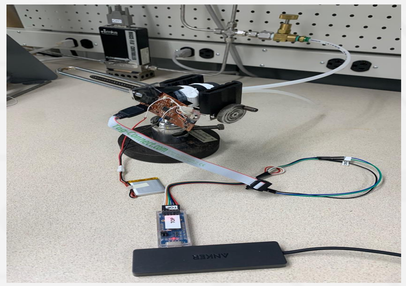
- Students get a chance to research this technology, understand how it works, and then pick a community that could benefit from it.
- Students then use the same technology to design and construct a solution for an additional problem this community is facing.

Method

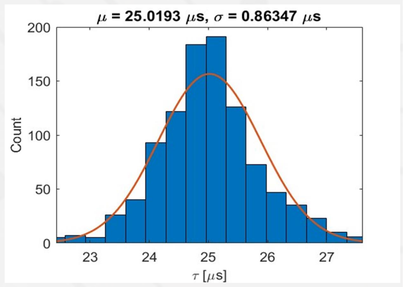
- A glass gas chamber was used to create a nitrogen-oxygen mixed environment for testing.
- Films were secured inside the chamber to create an airtight environment, while an LED mounted on a PCB was positioned outside the chamber, facing the film.
- For each oxygen pressure an LED was flashed 1000 times and the lifetime of the luminescence (tau) was recorded.



Sensing Principle

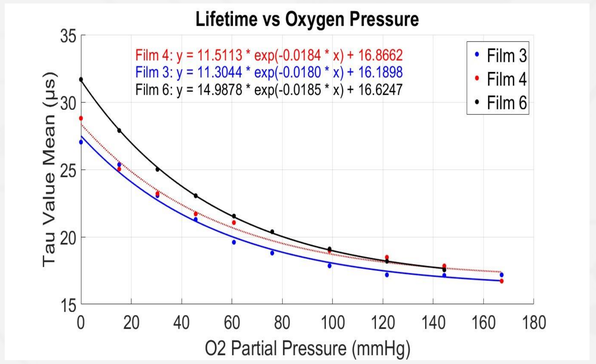


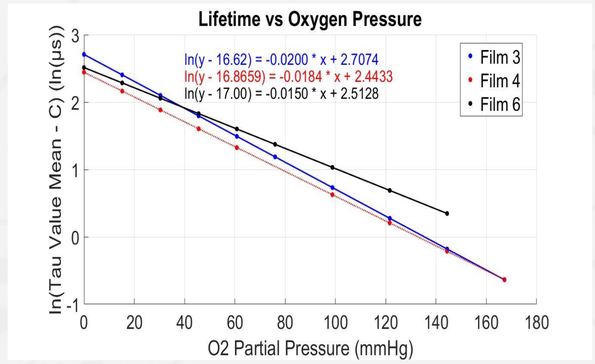
Set-up



Lifetime Deviation

Preliminary Findings





Conclusion

By linearizing the data, we aim to extract information about the offset between each dataset and gain of each line, to devise a calibration algorithm to correct the sensor readings.

Future work

1. Devise an equation for temperature dependency through collected real data.

2. Devise an equation for drift through collected real data.

3. Create calibration algorithms on the firmware and correct the sensor readings.

References

[1] - Naghavi, Mohsen, Cat Antony, and Michael Brauer. 2023. "Global burden of chronic respiratory diseases and risk factors, 1990–2019: an update from the Global Burden of Disease Study 2019." Institute for Health Metrics and Evaluation. https://www.healthdata.org/research-analysis/library/global-burden-chronic-respiratory-diseases-and-risk-factors-1990-2019
[2] – Vakhter, Vladimir, et al. "A prototype weqarable device for noninvasive monitoring of transcutaneous oxygen." IEEE Transactions on Biomedical Circuits and Systems vol. 17, no. 2, pp 323-335, 2023

Acknowledgements

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