ROEU 2016-17

Research Opportunities for Engineering Undergraduates (ROEU) Program

1-1-2017

Benchmarking of a Personal Air-Sampling Device

Russell Charles
Wayne State University, el2169@wayne.edu

Benchmarking of a Personal Air-Sampling Device

College of Engineering

Russell Charles

Dr. Chin-An Tan and Dr. Joseph Caruso

Mechanical Engineering

Opportunity and Significance

Long term exposure to low concentrations of environmental pollutants can lead to a negative impact on our health. Accurate and precise measurements of these pollutants is needed to quantify and better understand their effects. The goal of this project is to analyze and benchmark custom-built personal air monitoring devices.

Technical Objectives

Analysis of a custom-built personal air sampling devices investigated the following:

- Airflow readings
- Consistency of air flow as obstructions accumulate.
- Battery performance

Primary questions of investigation included:

- Did the device maintain a 1LPM flow rate throughout the study?
- How did voltage supplied to the pump scale if the intake valve becomes occluded?
- Did battery capacity fade over course of the study?

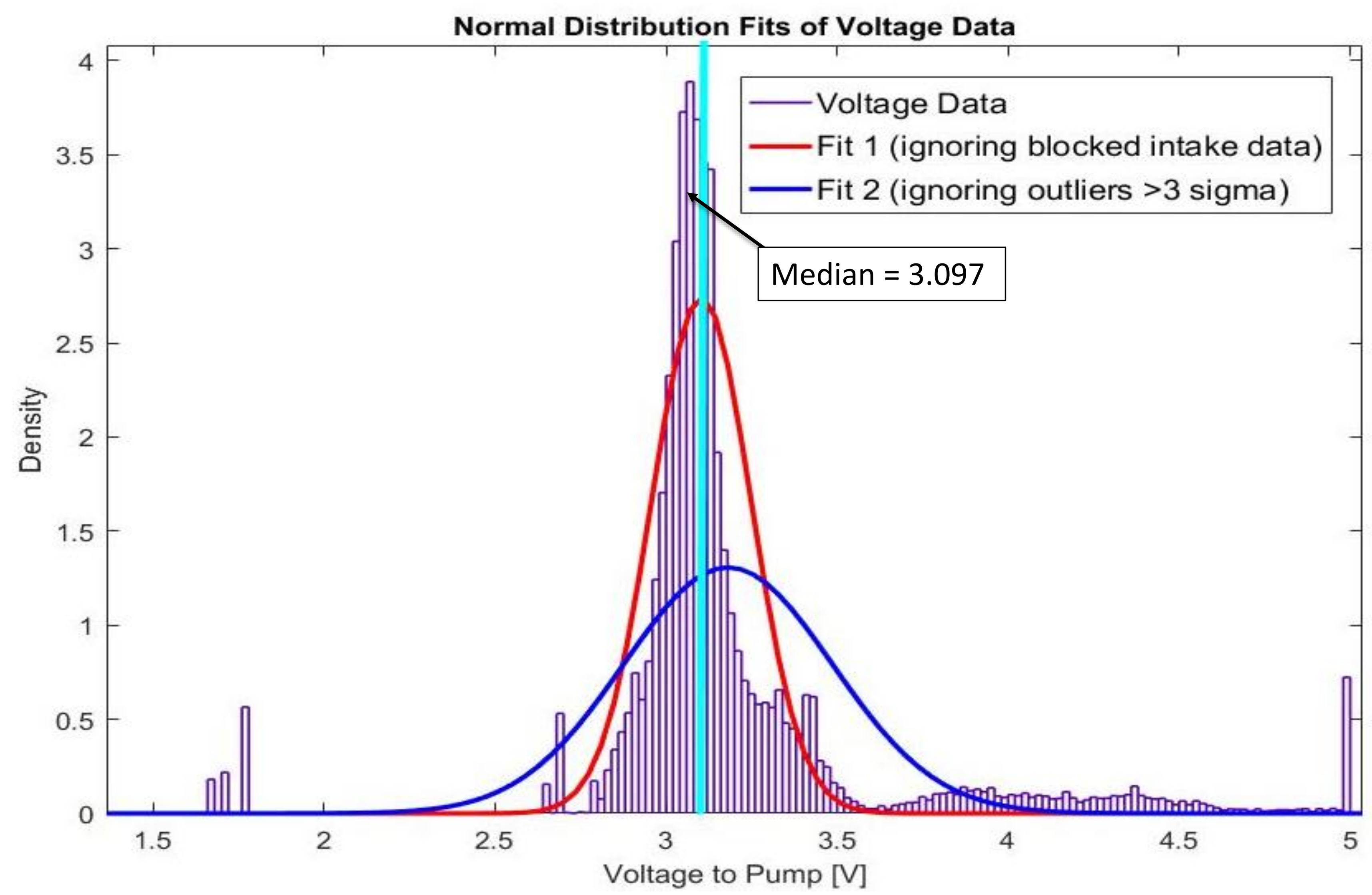
Related Work and State of Practice

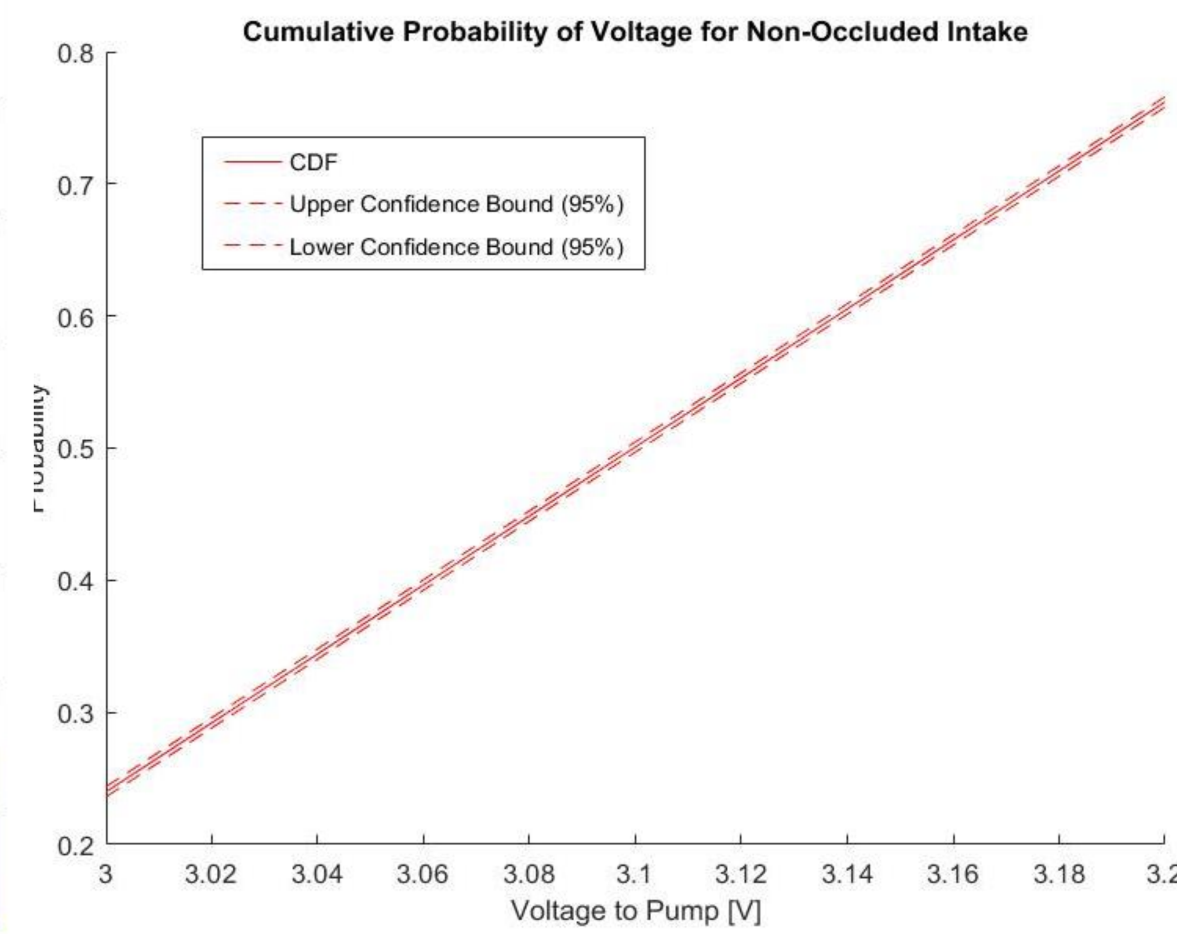
Many air-pollutant studies use static air monitoring stations to determine pollutant concentration in an area. Various models are then applied to estimate the human exposure. Dr. Caruso seeks to improve current methodologies for measurement to account for individual differences in daily travel and life styles, with a focus on Detroit teens with asthma.

Technical Approach, Accomplishments and Results

Analysis of Airflow

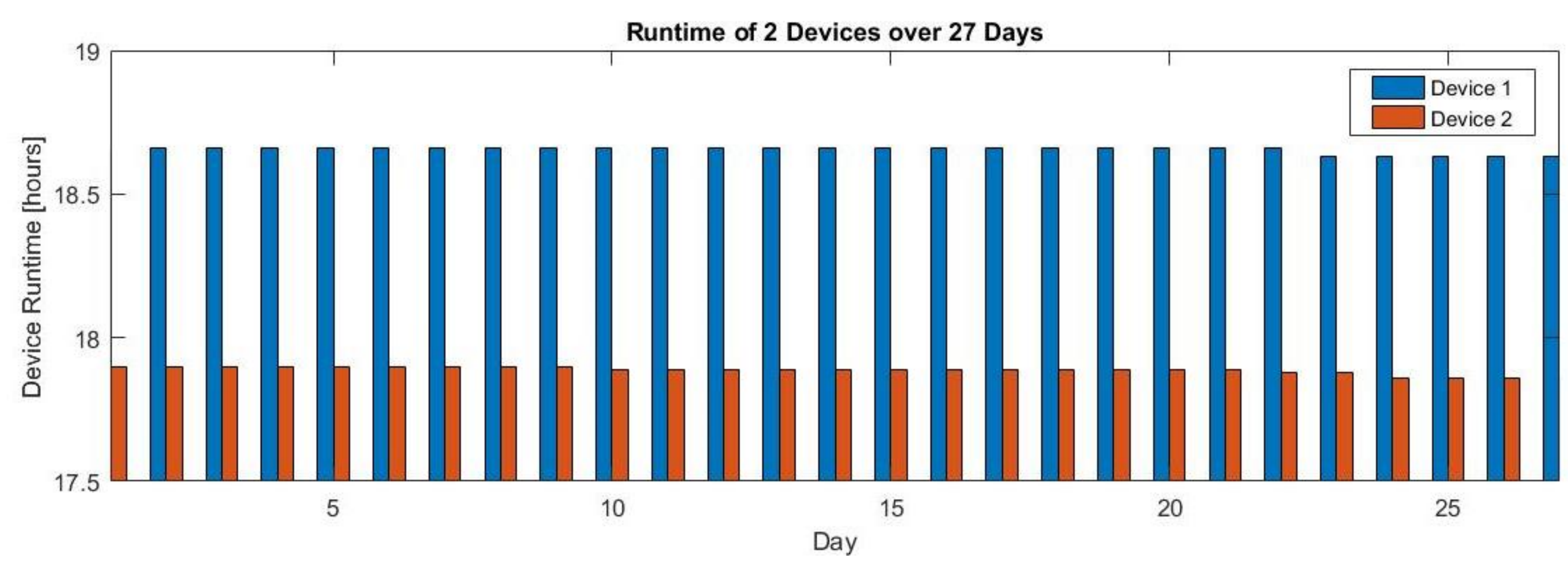
- Data analyzed from 13 devices, containing 1112 files (N = 35,375 voltage measurements).
- A supplied voltage of 3.1V @ 400 mA is required for an air flow rate of 1 LPM.
- Analysis of device data shows near constant flow rate is maintained approximately 76% during operation.





Analysis of Battery Performance

- Battery performance was validated by comparing experimental runtime to the theoretical runtime of 19 hours.
- A webcam was used to record continuous device operation for 27 days. At each night, after the battery energy was depleted, the device was allowed to recharge until at 100% SOC.
- Neither device was able to run for 19 hours, however no remarkable capacity loss of the battery was observed.



This project is funded by a pilot award from the Institute for Population Studies, Health Assessment, Administration Services and Economics (INPHAASE), a joint program from Wayne State University and the Henry Ford Health System

Next Steps for Development and Test

Further Testing

- Vibration testing for effect on air flow consistency, battery voltage, and mechanical endurance.
- Thermal testing of battery and pump for a range of ambient temperatures.
- Cycle life of device battery cells.

Future Developments:

- Reduction in device size and sound generation.
- Improved ergonomic case design.
- Transition to dual-layer PCB for wire free design.
- Improved battery chemistry to ensure sufficient runtime, while not increasing size.

Commercialization Plan & Partners

Partners:

- Prisma Dynamics LLC designed and assembled the original custom device.

Plan:

- Market with the strategy of custom technology solutions.
- Critical components will be ordered from online suppliers, such as the PCB.
- Final assembly will be continue to be completed by Prisma Dynamics LLC.

Challenges:

- Implementation of future development decisions.
- Obtaining patent for technology.
- Determine correct production volume.

References

- Caruso, Joseph et al. Petroleum Coke in the Urban Environment: A Review of Potential Health Effects." *International Journal of Environmental Research and Public Health*" 29 May 2015. Web.
- DeGuire, Peter et al, "Detroit: The Current Status of Asthma Burden." March 2016, Microsoft PowerPoint file