Personal Bio-Meteorological Station based on Cylindrical Radiation Thermometers and Turbulence Accounting Anemometers

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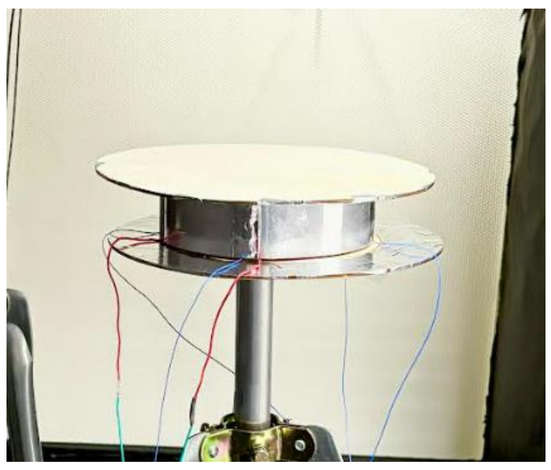
Research Motivation: This project seeks to address how to affordably and accurately measure the convection heat transfer coefficient of the human body in turbulent outdoor flow. For almost 150 years, the Earth has been experiencing the effects of global warming: heat waves, long lasting droughts, and increasing temperatures. These types of climate change can be dangerous to human beings and could lead to heat exhaustion, fainting, nausea, etc.

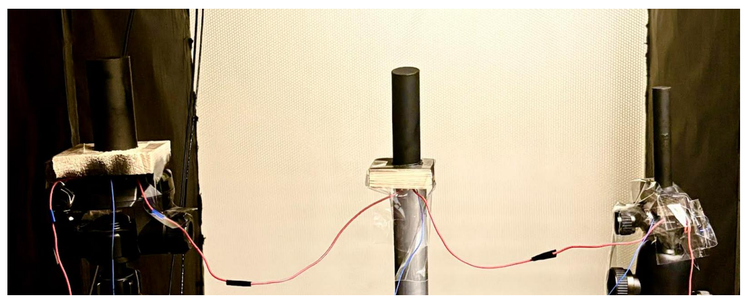
Possible Solutions:

Current Expensive Solution: Thermetrics' Andi (thermal manikin)

Affordable Solution #1: Cylinder with Equivalent Diameter to ANDI

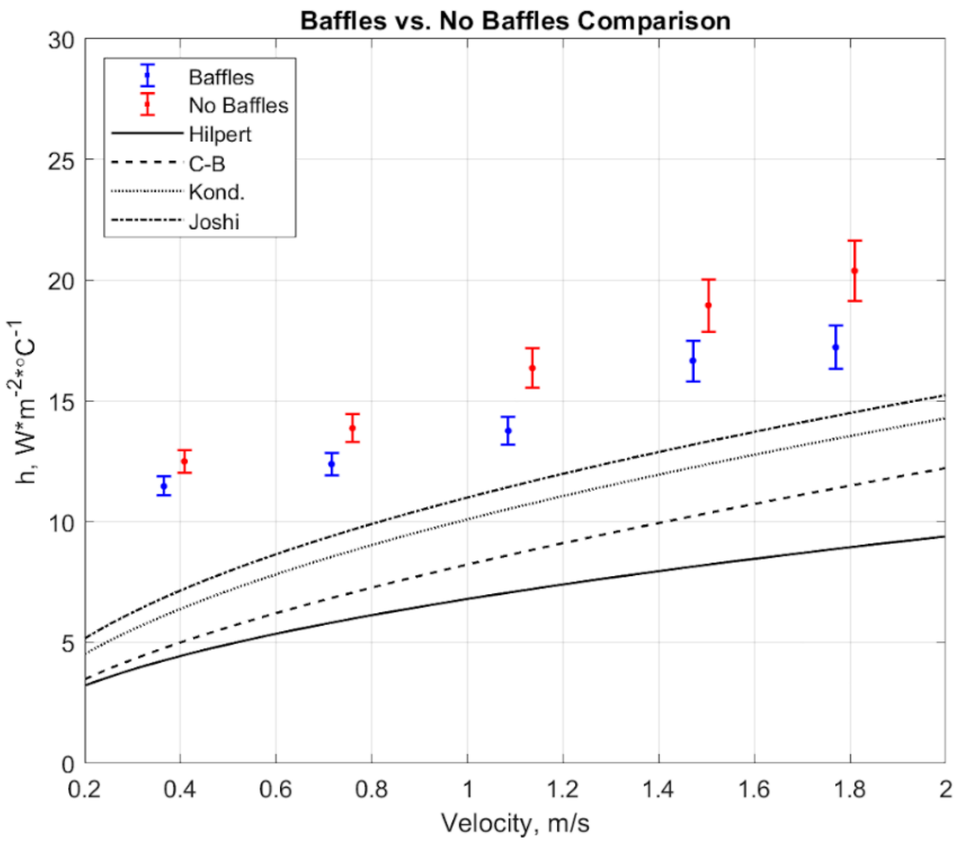


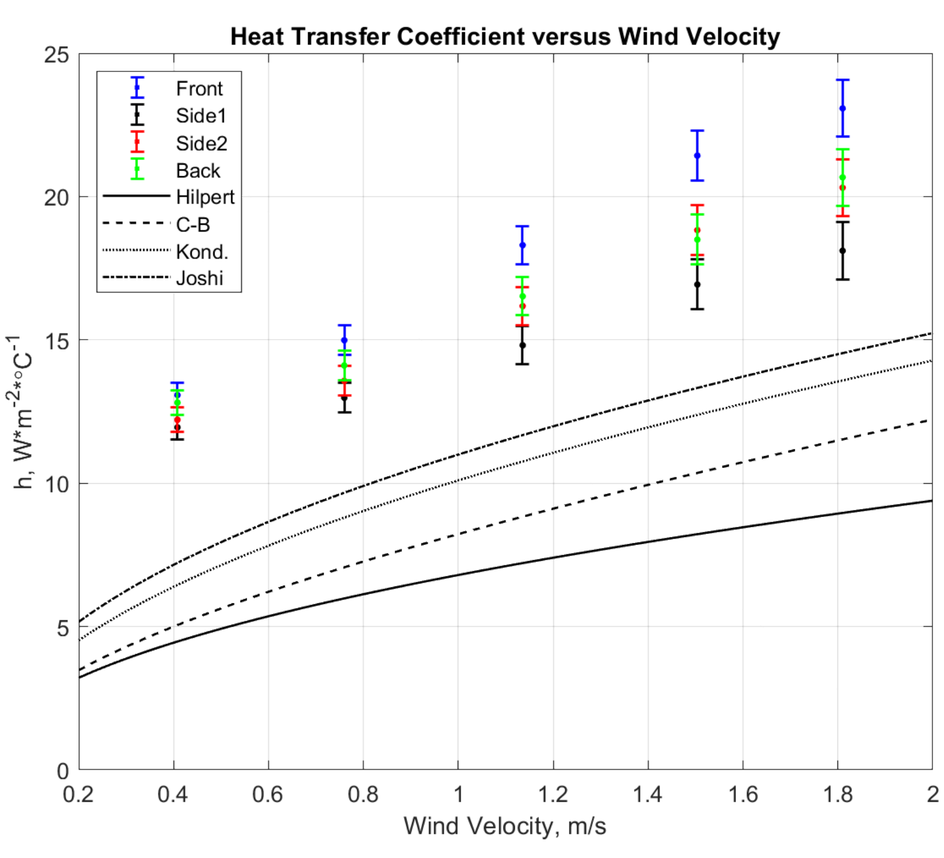
Affordable Solution #2: 3 Cylinders Setup with Equivalent Diameter to ANDI



Construction/Experimentation: Two different setups for affordable solution #1 were tested in a low-speed wind tunnel. The cylinder was fabricated out of copper sheet metal with Styrofoam placed in the center as an insulator. Four thermocouples were epoxied to the surface. Five flexible heating plates were adhered to the inner surface walls. The cylinder was wrapped in aluminum tape, with a known emissivity. Setup 1 utilized baffles on the open cylinder ends to prevent excess heat loss, whereas setup 2 utilized excess Styrofoam.

Results/Conclusions:





Compared to findings from ANDI and other published correlations, the heat transfer coefficient for this setup is high. This is likely due to excess heat loss through the ends of the cylinder, since the height to diameter ratio is rather small. As the velocity increases, the differences in measurements between the 4 thermocouples increases, which will need to be accounted for in future work.

Future Work:

1. Double height of Solution #1 and increase insulation to prevent excess heat loss.
2. Perform testing of Solution #1 in outdoor turbulent conditions.
3. Perform testing in wind tunnel of Solution #2 to determine if this setup is a viable alternative to Solution #1.

References: Churchill, Bernstein, 1977; Hilpert, 1933; Joshi, 2024; Kondjoyan, 1993, ANDI: https://thermetrics.com/products/manikin/andi/

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