Monitoring of Wireless Internet Devices in Field Research using Hybrid Energy Automated Robots

Consortium of Hybrid Resilient Energy Systems Technical Forum

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Morgantown, West Virginia

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About Me

Co-ops Experience

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Research Projects

SDC STUDENT DESIGN COMPETITION UPRM

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SOMNUS

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Figure 1-4. Collage of summer experience. Working on sensors in the field (upper left). Setting up a LEWIS kit in the lab (bottom left). Building a Prusa MK3S + in the lab (middle). Checking the wiring of the robot in field (right).

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Background

- Project: Hybrid Energy Systems for Remote Wireless Sensors
- Lead Professor: Dr. Fernando Moreu
- Job Roles: Mechanical Design Engineer & Researcher
- Problem Statement: Continous interruption of data recollection due to wireless internet devices disconnecting in the field.
- Identifying the possible causes and root causes.

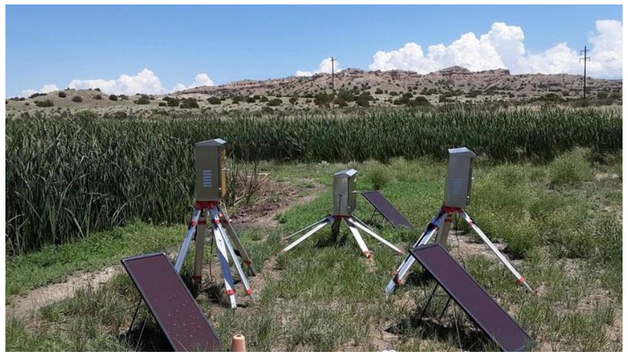

Figure 5-7. Sensor networks in a field location in Santa Fe (left). Wildfire in Santa Fe (middle). Flooding marks in field location (right).


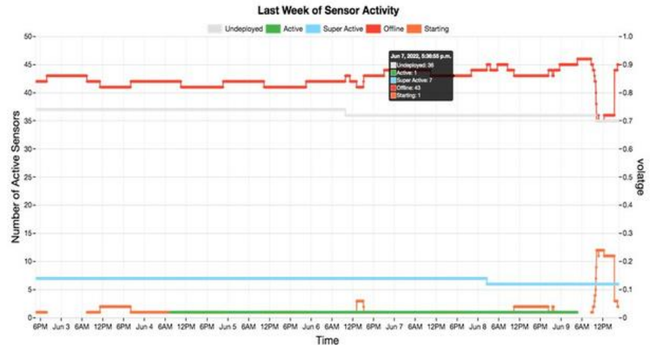

Figure 8-9. Mifi Jetpack 8800L (left). The graph displays the various sensor operating states as well as the number of sensors in each (right).

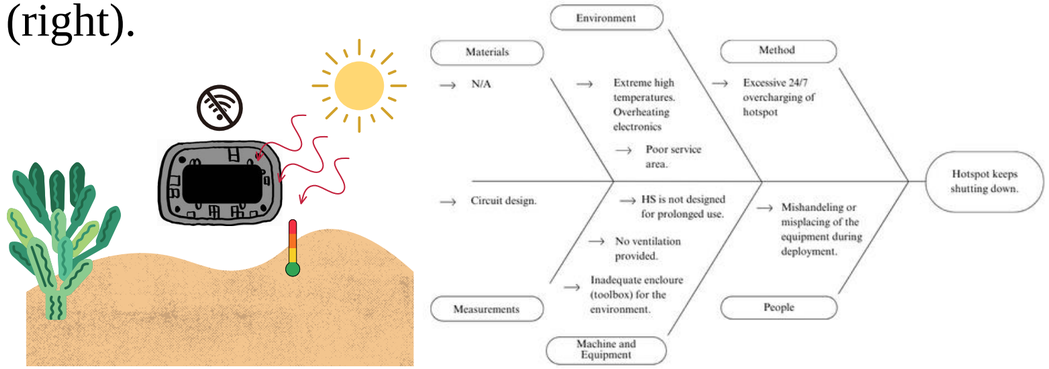

Figure 10-11. Diagram (left). Ishikawa diagram (right).

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Computer-Aided Design

Design Intent

- Monitor and detect internet signal disconnections.
- Push down and hold the hotspot button for reset.
- Casing with precise dimensions for hotspot and robot positioning.
- Ventilate hotspot for optimal temperature.
- A customizable design for future add-ins.
- Portable, compact design for outdoor electronics enclosure box.
- Design for comfortable disassembling, inspection, maintenance, and changing placement within the enclosure.

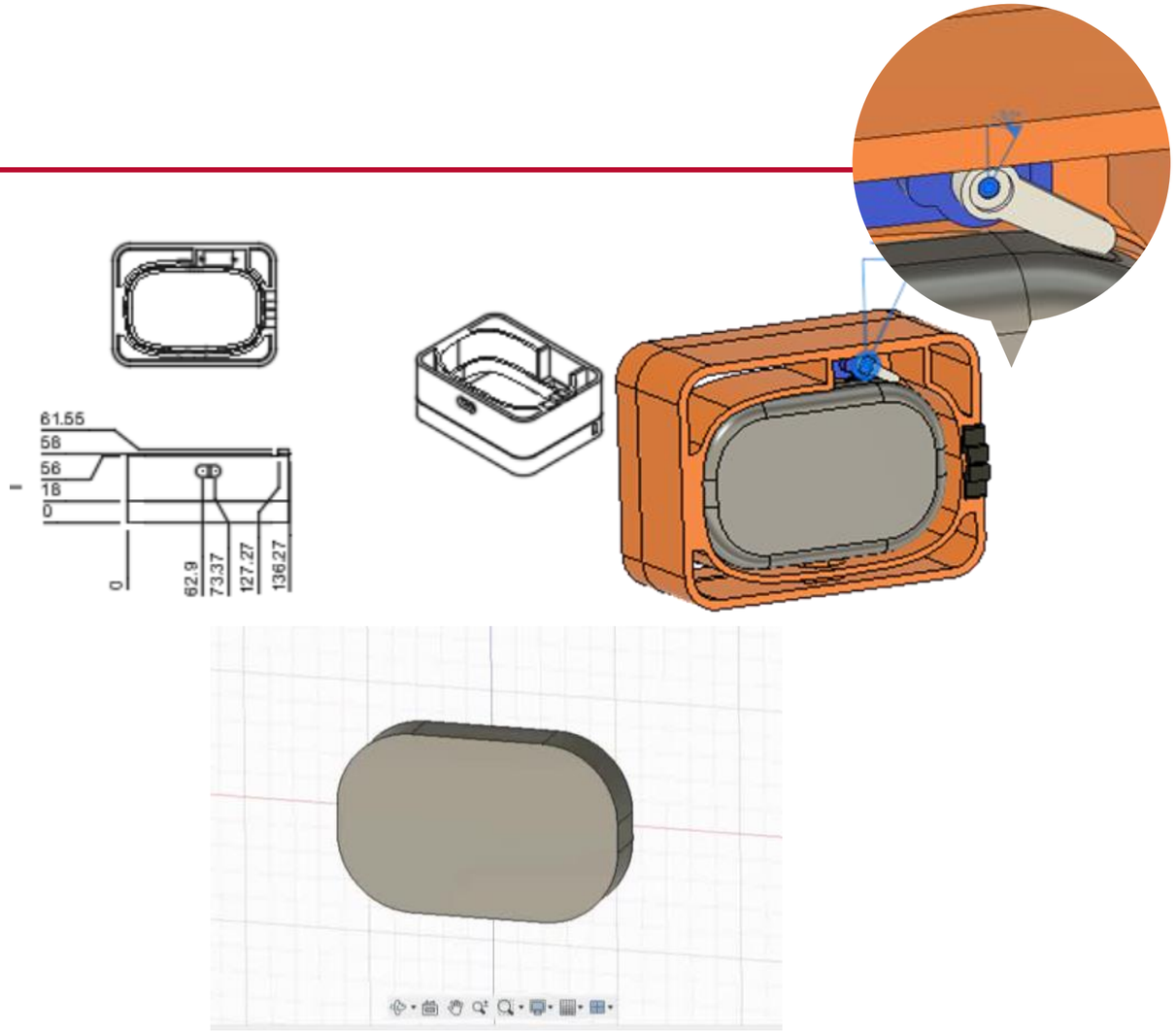

Figure 12-14. Top, bottom, and right side view of casing (upper left). Angle in which the mechanism travels (upper right). Timelapse of the CAD (bottom).

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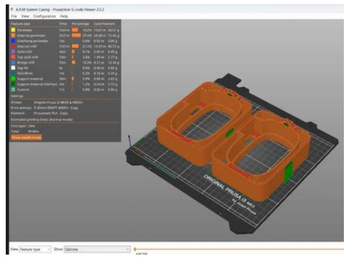
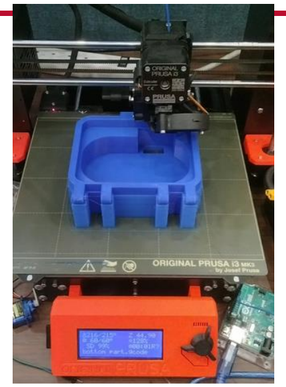
3D Printing & Deployment

- Testing the concept.
- Eight cases 3D printed.
- Prusa MK3S+ v3.18.
- PLA Filament
- EVA Foam
- 4 hours 12 min per print.

Figure 15. First successful testing of the robot.





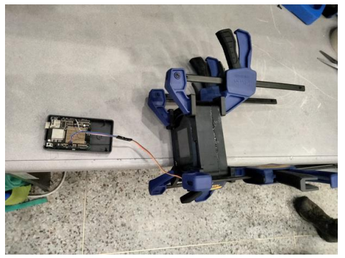


Figure 16-18. Gcode in Prusa Slicer (left). One of the cases being printed in the lab (middle). Adding the EVA foam to the inner slots of the casing (right).

Figure 19-20. Deploying robot in field (left). Placing robot in new enclosure (right).

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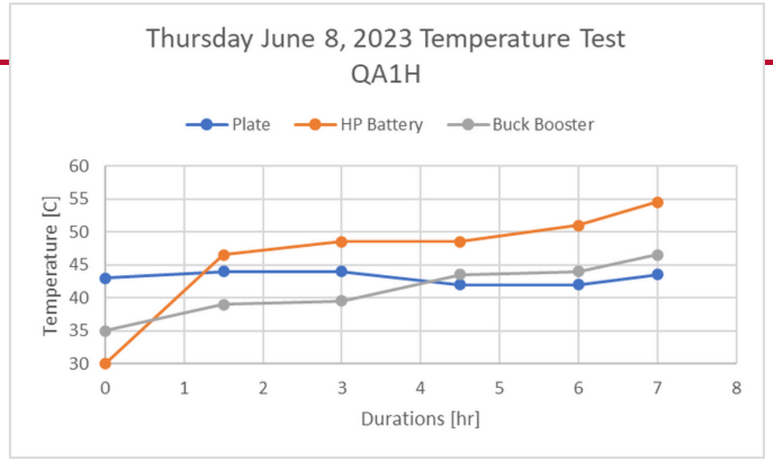
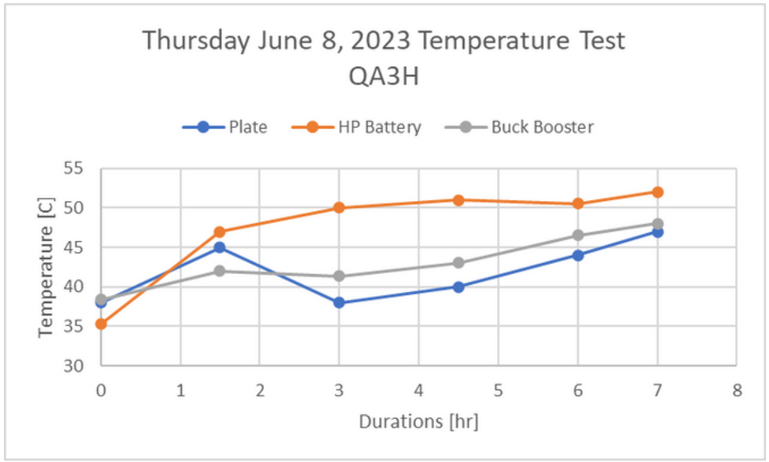
Thermal Measurements

Table 1. Temperature data collected during operation in a day.

		Temperature [Celsius]					
		QA3H, n7, s70, r32			QA1H, n4, s81, r23		
Time	Duration [hours]	Plate	HP Battery	Buck Booster	Plate	HP Battery	Buck Booster
10:28 AM	0	38	35.3	38.4	43	30	35
12:00 PM	1.5	45	47	42	44	46.5	39
1:45 PM	3	38	50	41.35	44	48.5	39.5
3:05 PM	4.5	40	51	43	42	48.5	43.5
4:35 PM	6	44	50.5	46.5	42	51	44
5:30 PM	7	47	52	48	43.5	54.5	46.5





Graph 1-2.Temperature vs time of two different enclosures in the same field location.

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Experiment

Research Question	Independent Variable	Dependent Variable
Can the orientation of the enclosure with respect to the sun's trajectory affect the temperature of the components inside the enclosure?	The enclosure position and orientation are parallel and perpendicular to the sun's trajectory.	The temperature change in the Hotspot battery and inside walls of the enclosure.

Hypothesis

Placing the orientation parallel and coincident with the sun's trajectory will decrease heat transfer by lessening the exposure of the surface area to the solar rays.

Experiment Idea

Place two enclosures in different orientations and take temperature data throughout the day.

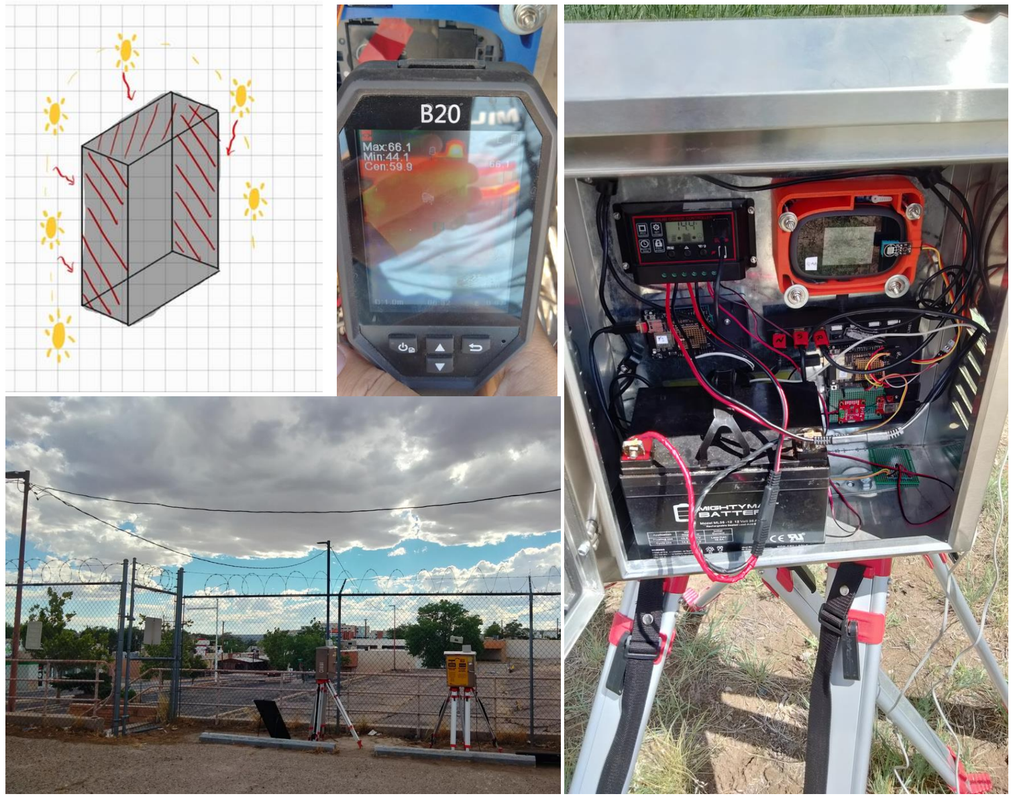

Figure 21-24. Sun path trajectory (upper left). HIKMICRO Thermography Camera (upper right) Orientation experiment photo(bottom left). Open enclosure (bottom right).

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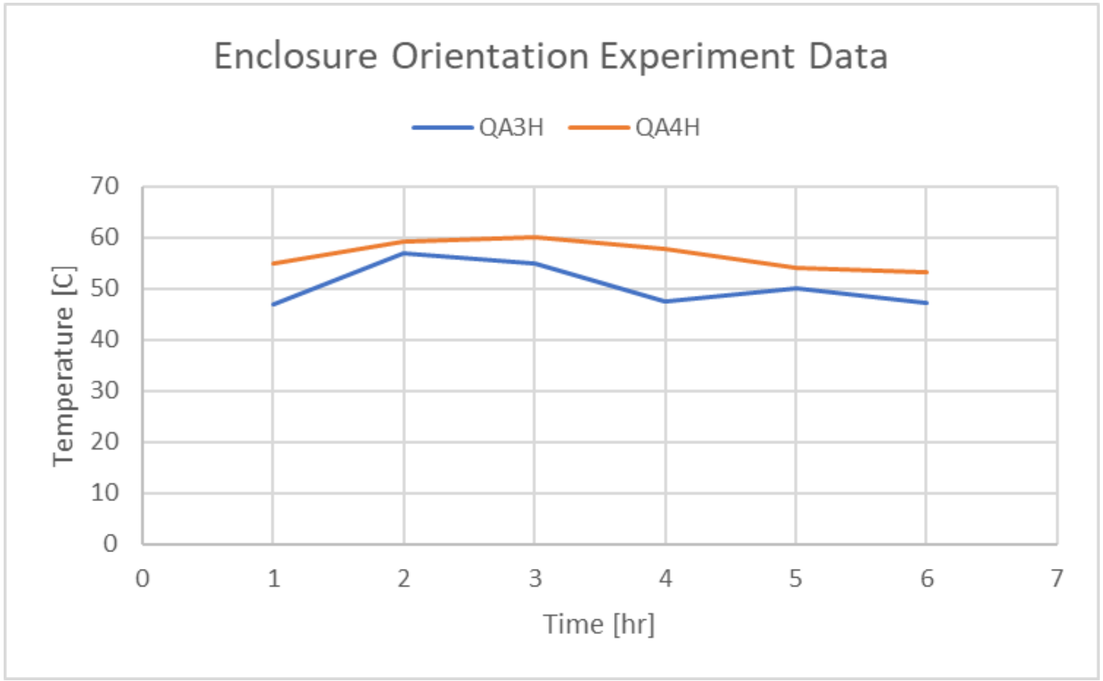
Results

Table 2. Temperature data collected from two different oriented enclosures.

		Temperature [Celsius]								
		QA3H, n7				QA4H, n3				
Time	Duration [hours]	HP Battery				HP Battery				
		Max	Min	Center	LEWIS Website	Max	Min	Center	LEWIS Website	Delta Temp
12:30:27 PM	0	55.4	38.5	46.8	44.4	58.7	49.8	54.9	45.3	8.1
3:22 PM	3	58.2	45.4	57	52.7	64.3	42	59.3	52.7	2.3
4:29 PM	1	58.6	43.9	54.9	50.3	66.1	44.1	60	53.2	5.1
5:04:36PM	0.5	56.7	42.1	47.4	46.2	58.7	51	57.7	49.2	10.3
5:35 PM	0.5	51.3	43.2	50.2	43.9	60.1	37.9	54.2	47.1	4
6:00 PM	0.5	48.3	39.6	47.2	43.9	53.5	39.6	53.3	46.2	6.1



Graph 3. Comparison of temperature data between two different oriented enclosures.

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Heat Transfer Analysis

Table 3. Hotspot specifications.

Description		Variable and Value
Mifi 8800L Hotspot	The battery heat dissapation.	Qb=16.7 W*h
	The maximum surface temperature of the battery.	Ts, max=40 ℃
	Battery height.	H=0.127 m
	Battery length.	L=0.4064 m
	The space between battery and plate.	s = 0.005 m

Table 4. Cooling fan specifications.

Cooling Fan	The power of the cooling fan.	Wf= 1.44 W
	Radius	r = 200 mm
	Max Speed Required @T=25 C	V=7.540 m/s V=2.40 m/s
	Air Volume	CFM =38

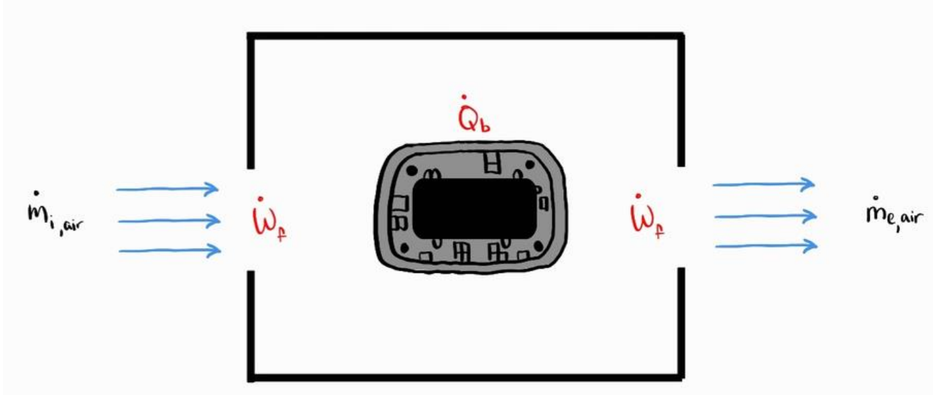

Figure 25. Heat transfer internal convection diagram of the hotspot device.

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K. Delker, “UNM awarded Civic Innovation Challenge grant for post-wildfire resilience project,” UNM Newsroom, Sep. 21, 2021. Accessed: Jul. 05, 2023. [Online]. Available: https://news.unm.edu/news/unm-awarded-civic-innovation-challenge-grant-for-post-wildfire-resilience-project

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Truly grateful.

Thank you!

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Q&A

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