ENTS NODE ENCLOSURE

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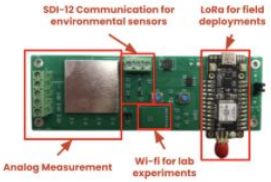
Overview

UCSC and UCSD researchers created the open source Environmentally Networked Sensor (ENTS) as an easy and low cost way of conducting environmental research[1]. This enclosure is deployed outdoors for weeks on end with sensors. We were tasked with creating an optimized enclosure for marsh deployments.

GitHub

DirtViz

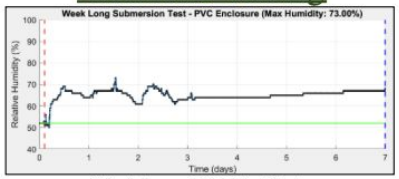


ENTS Node Diagram

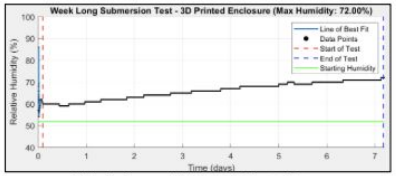
Enclosure Requirements

- **Waterproof**
- **Low cost (< $40)**
- **Allows for passage of sensor cables**
- Deployable for one week
- Allows wireless data transmission
- Reproducible by lab researchers
- UV resistant
- Non-toxic to the environment

Enclosure Testing



Week-Long PVC Test Data



Week-Long 3D Print Test Data

Enclosure Designs

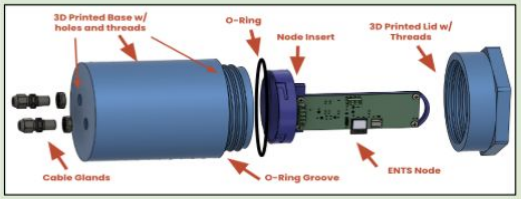
PVC

Exploded View of all Components

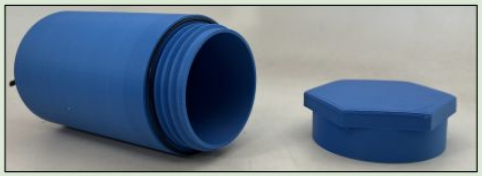
Assembled PVC Enclosure

- Off-the-shelf PVC (SCH 40) Components
- Passed Week-Long Submersion Test

3D PRINTED



Exploded View of all Components



Assembled 3D Printed Enclosure

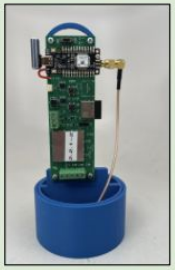
- PLA, 7 Perimeters, 40% Infill, Sealant
- Passed Week-Long Submersion Test

INDIVIDUAL COMPONENTS

Node Insert Module

- 3D printed twist-lock insert secures ENTS node to enclosure
- Allows for sensor cable management space

Exploded View of Insert and Node



Insert and Node Assembly

Exploded View of Cable Gland[3]

O-Ring and CAD of O-Ring Gland

Silicone Coating Sealant

Cable Glands

- Allows for passage of sensor cables while maintaining waterproof rating

O-Rings

- Provides a waterproof seal for 3D printed enclosure
- Follows industry standards and design analysis[2]

Sealants

- Increases waterproofness and longevity of enclosure
- Reduces toxicity of materials to environment

Design Comparison

	3D Printed	PVC
Raw Cost	$28	$35
Build Time	15 minutes	30 minutes
Idle Time	20 hours	2.5 hours
Tool Requirements	3D printer, sealant	PVC cement, power drill, saw
Concerns	Longevity, reproducibility	Size, scalability

Enclosure Instruction Manual

Conclusions

- Both enclosures were deployed for a week with no water leaking inside

Future Recommendations:

- More long-term testing
- Optimize 3D printing settings

Impact on Society

- Lowers cost and access barrier for independent environmental researchers and labs across universities
- Enclosures may release microplastics into deployed environments, but this risk was reduced by introducing sealants
- Allows UC researchers to invest resources used on previous enclosures elsewhere

Acknowledgements

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- **Engineering Staff:** Chris Cassidy, UCSD MAE
- **Course Teaching Assistants:** Jackie Chen & Jackelin Amorin, UCSD MAE

References

(1) Madden, John, et al. "Hardware to Enable Large-scale Deployment and Observation of Soil Microbial Fuel Cells."

(2) Parker Hannifin Corporation. *Parker O-Ring Handbook.*

(3) RS Pro. "Black Nylon Cable Gland"