

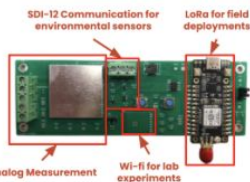


ENTS NODE ENCLOSURE

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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.

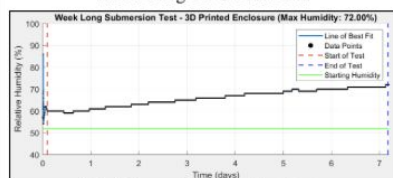
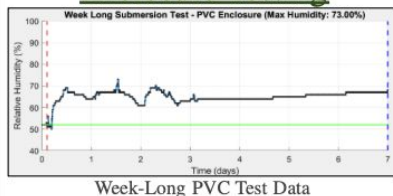


ENTS Node Diagram

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



Enclosure Designs

PVC



Exploded View of all Components



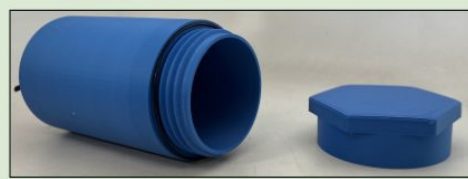
Assembled PVC Enclosure

- 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

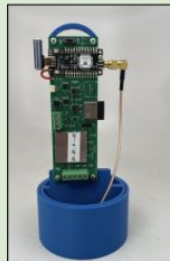
INDIVIDUAL COMPONENTS

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 | 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"