Limpet: an Autonomous Bioinspired Robot for Environmental Monitoring

THE UNIVERSITY of EDINBURGH

ORCA HUB
Offshore Robotics for Certification of Assets
Remote Safety and Integrity

LIMPET: AN AUTONOMOUS BIOINSPIRED ROBOT FOR ENVIRONMENTAL MONITORING

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- The Limpet

The Limpet was born as the answer to the industry urge to monitor remotely harsh off shore environments, as such it is capable of several exteroceptive sensing modalities, robust in communication, portable, long leaving, low cost and low energy.

- Water Applications

Focus: LED turbidity measurements

Application: turbidity measurements for clean water and offshore hazardous substances detection

- Experiments & Results

Calibration using standard off-the-shelf turbidimeter

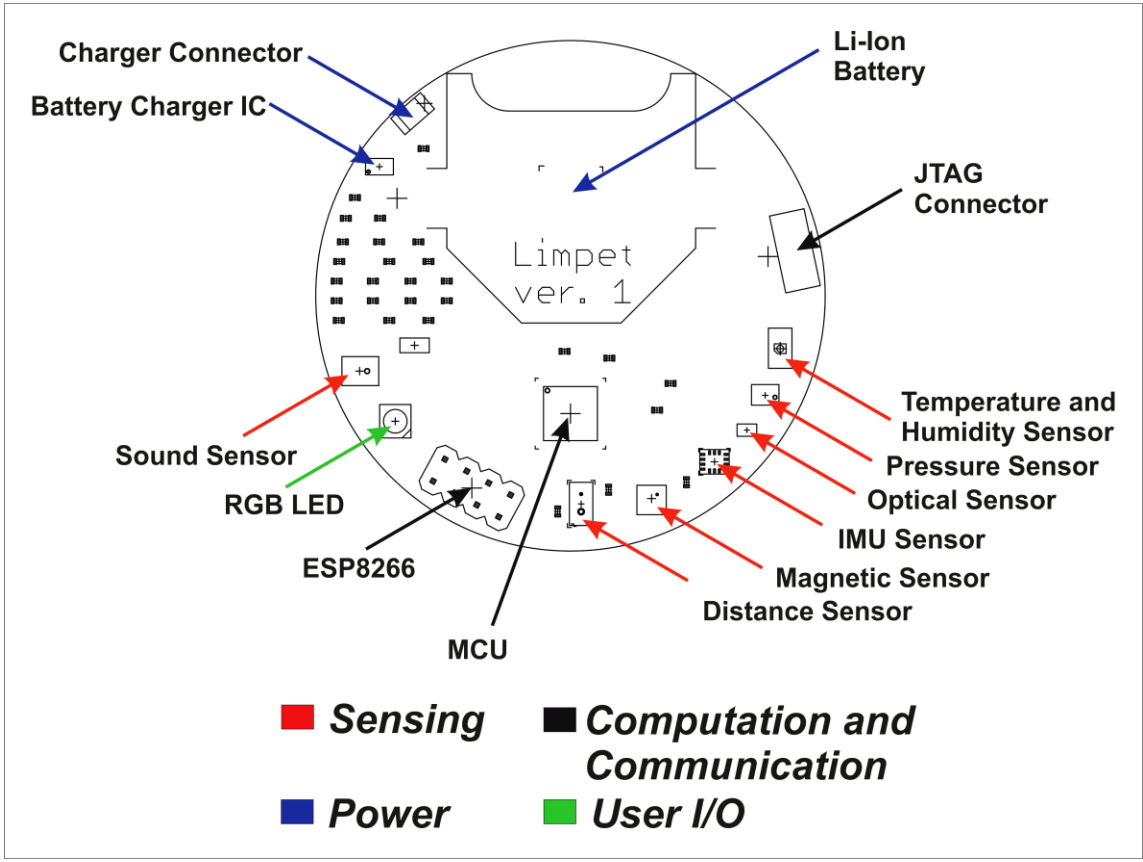
Light setting assessment

- Future work

The potential of the Limpet is huge: energy harvesting, underwater applications, etc…

The Limpet

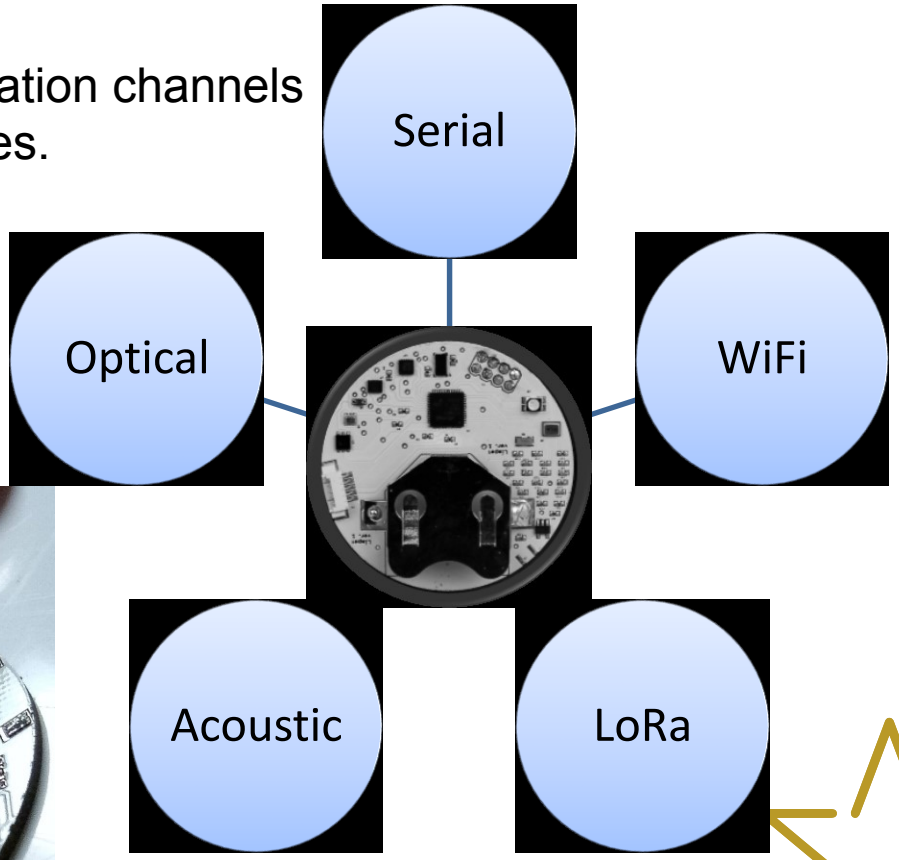
- 9 sensors
- Low cost: 20 £
- Low power: 182.9/0.1 mA
- Life time: 67 days/52 mins
- Portable: 50 mm

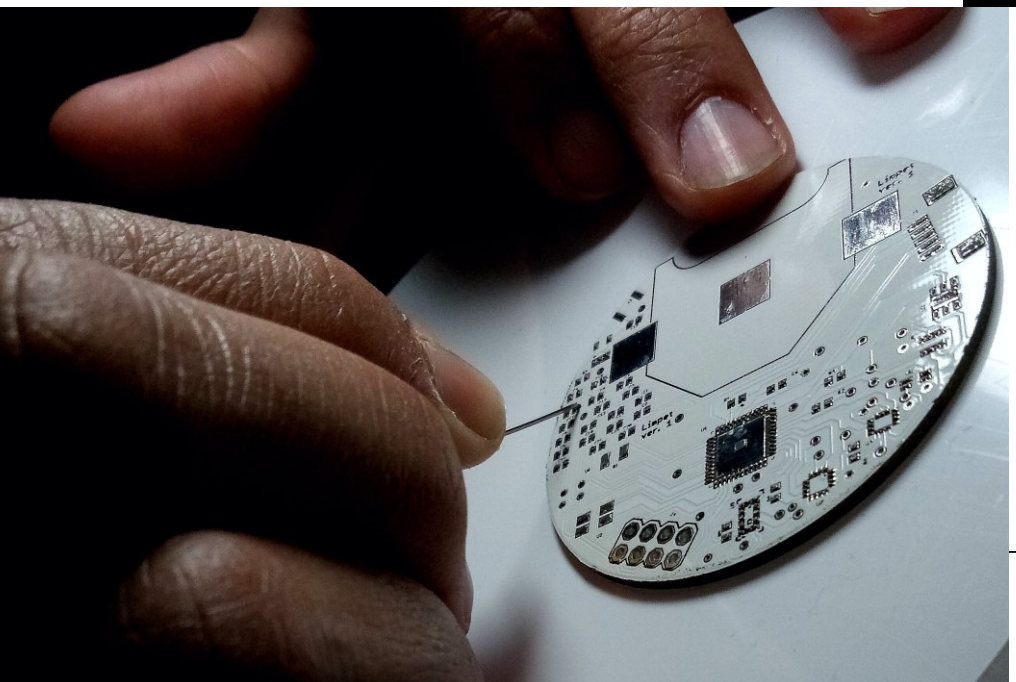


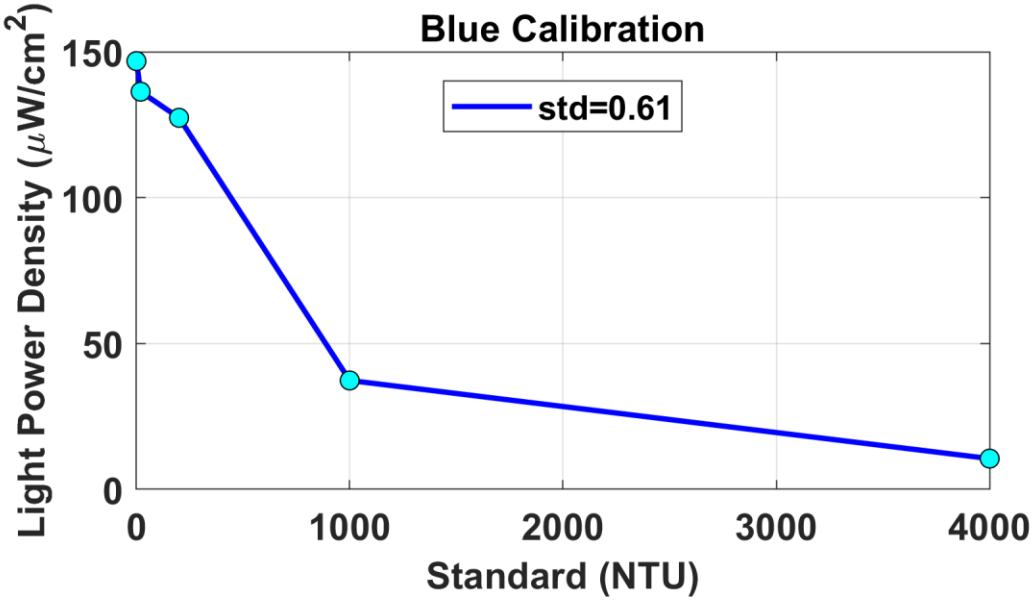
Sensor	Sensor Modality	Measurements
Accelerometer	Acceleration	• Acceleration (x, y, z) • Temperature
Gyroscope	Angular Velocity	• Angular Velocity (x, y, z) • Temperature
Temperature Sensor	Temperature	• Temperature
Humidity Sensor	Humidity	• Relative Humidity
Microphone	Sound	• Sound Frequency
Pressure Sensor	Pressure	• Temperature • Pressure • Altitude
Hall-Effect Sensor	Magnetic Field Strength	• Magnetic Field Strength (x, y, z) • Temperature
Optical Sensor	Light Frequency	• Correlated Color Temperature • Red/Green/Blue Light Power Density • Ambient Light Intensity
Distance (Time-of-Flight) Sensor	Laser	• Distance (Range)

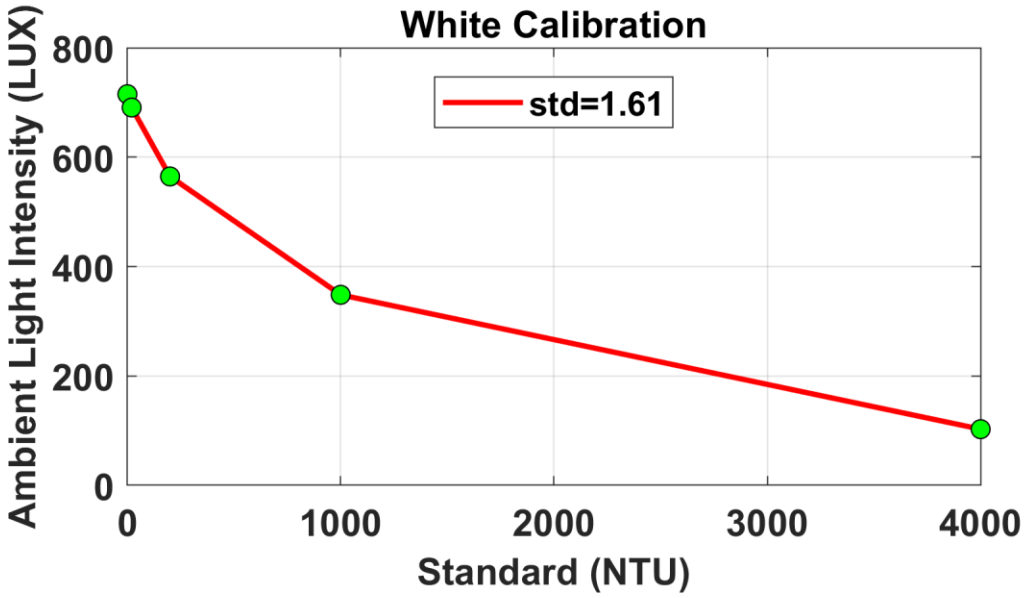
Robust Communication:
the Limpet blends traditional communication channels with the latest communication techniques.

Communication Fail-over
the Limpet is able to switch between different communication channels if it is needed, e.g. in case of failure



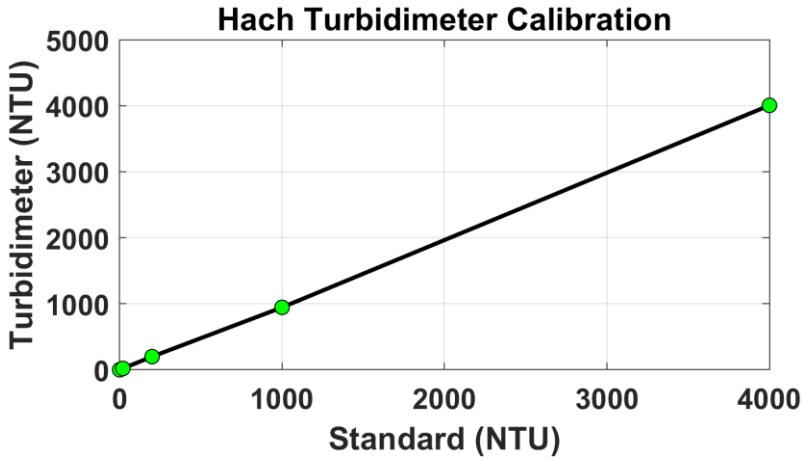


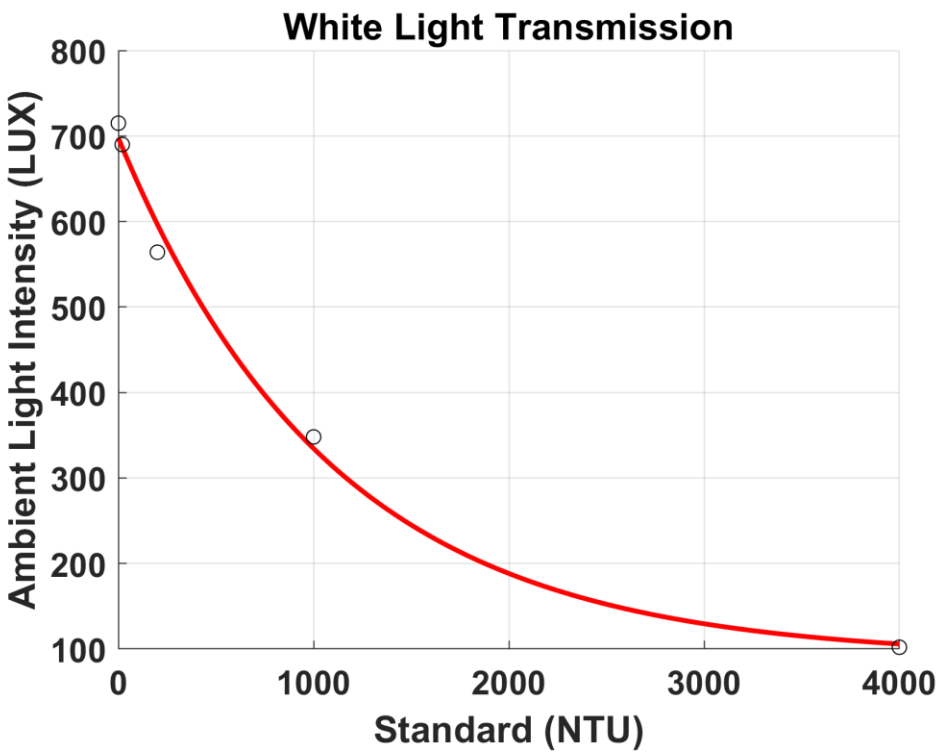


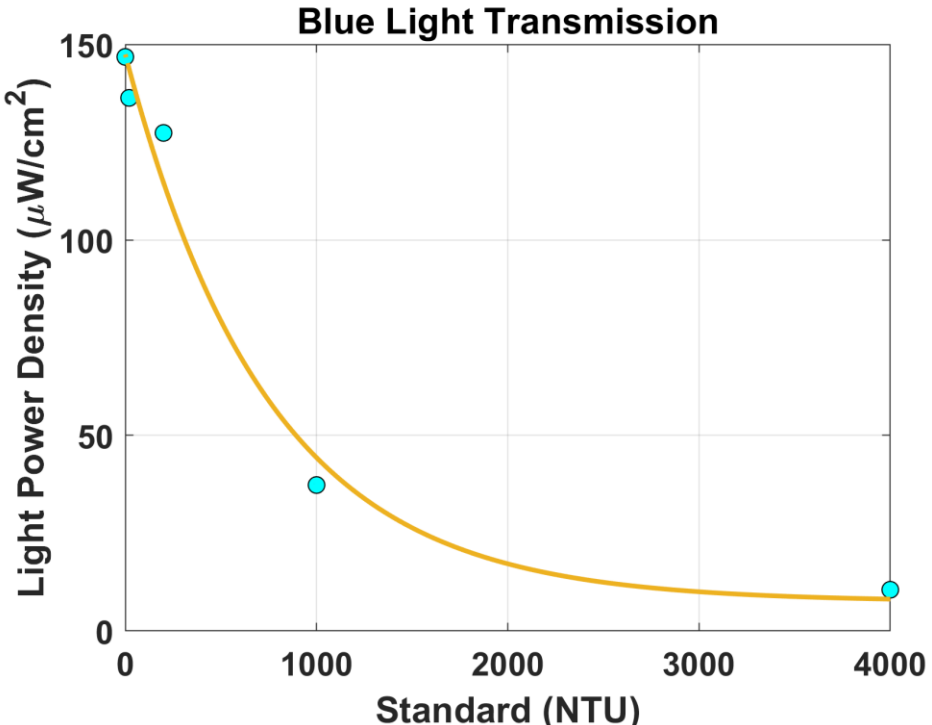


We ran measurements using solutions with a known turbidity level, i.e. Stabilized Formazin Turbidity Standards.
The results displayed refer to:

- Hatch Turbidimeter
- Limpet Blue Light transmission
- Limpet White Light transmission




White Light Transmission
Ambient Light Intensity (LUX)
800
700
600
500
400
300
200
100
0
1000
2000
3000
4000
Standard (NTU)

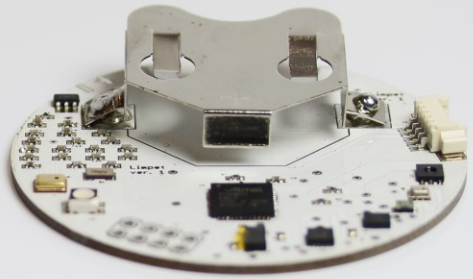

Blue Light Transmission
Light Power Density (μW/cm^2)
150
100
50
0
0
1000
2000
3000
4000
Standard (NTU)

SOLUTION TESTING

Solutions measured by the Hatch Turbidimeter	
	MEAN±STD
Lemon Juice	577.7±48.6 (NTU)

Solutions measured by the Limpet with blue LED	
	MEAN±STD
Lemon Juice	72.2 ±0.70 (uW/cm2) 572 (NTU)

Solutions measured by the Limpet with white LED	
	MEAN±STD
Lemon Juice	374.5 ±5.2 (LUX) 852 (NTU)



Future Work

- Improve the fitting curve with more calibration points

- Investigate the back scatter parameter

- Develop an underwater set up for environmental monitoring

THANK YOU