A low-cost Raman microscope for detecting microplastics in the ocean

Type of the project
Semester project

Laboratory
Laboratory of Nanoscience for Energy Technologies

Professor
Professors Giulia Tagliabue and Florian Breider

Supervisor
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Contact person at Sailowtech
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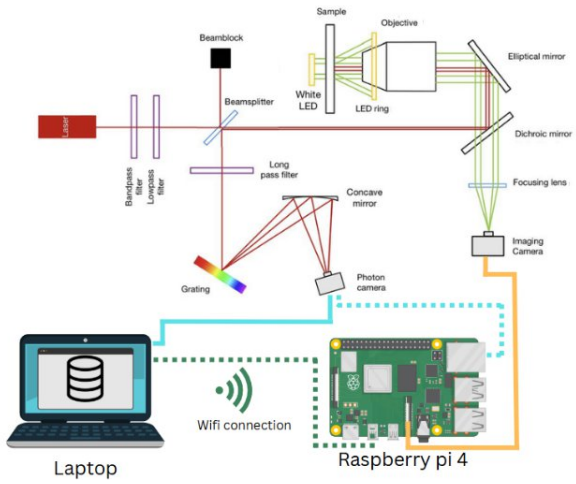
Student
To be determined

Context
Microplastics are a significant source of pollution in lakes and oceans worldwide. While this is well known, the effects of microplastics on the marine environment, and even the size and distribution of microplastics in the ocean, remains poorly understood. Thus, it is imperative that we develop methods to quantify environmental plastic pollution in water sources and be able to rapidly scale these methods.
Sailowtech is an association and a MAKE project that aims to raise awareness of environmental issues, particularly those relating to aquatic environments. It promotes frugal and participative field science, open-source science, and low-tech approach. To achieve this, Sailowtech organizes scientific sailing expeditions in lakes, seas, and oceans to discover field science, test the protocols and devices built by students during the semester.

Description of the project

Raman spectroscopy – which analyses the light scattered by a laser beam on a sample - is a technique that can be used to identify plastics, as each plastic has a unique optical fingerprint. Furthermore, when coupled to a microscope, plastics down to < 1 µm in diameter can be studied. However, most commercial Raman microscopes are bulky, expensive pieces of equipment not fit for use on a boat. **The aim of this project is to perfect a low cost, small Raman microscope that can be used on a Sailowtech cruise**

and that identifies microplastics in samples. Several examples of low cost Raman systems exist in literature, though these have not been adapted for use on boats.
A first prototype of the Raman technology was achieved last semester. A database (OpenRamanDatabase) was developed.
However, challenges remain.



This project will be broken into **two parts**:
i) a review of the low-cost Raman microscope system that was designed and constructed last semester
ii) the improvement of this one to overcome the remaining obstacles. A successful project will result in a device that can be used on a future Sailowtech cruise.

Remaining **challenges and objectives** are:

1) Improving the mechanical and optical configurations is essential, because the laser beam is not precise enough and arrives misaligned on the sample, resulting in poor Raman emission.
2) The microscope and spectroscope should be placed in an enclosed environment (ligh-tight).
3) The remote sensing station (Rasberry PI controlls microscope and spectroscope) should be adjusted, so that it is adapted to an expedition environment. For now, too many screens are needed, and it is not adapted.
4) Future tests with the implemented database have to be performed, as some parameter variations result in misidentification of the microplastic (e.g opacity and colour diffferences).
5) The algorithm to identify the microplastics from the pics in the spectrum of the sample should be reviewed. For now Gaussian-weighted algorithm was used, but whether this choice is relevant must be confirmed.
6) If multiple microplastics are present in the sample, the Raman struggles analyzing them.

The ideal student for this project will have a track record in design and fabrication of experimental equipment or other mechanical components (e.g. via 3D printing) and an interest in microplastics and optical spectroscopy. The student should also have experience in programming, the main language used will be Python.
Professor Breider has significant experience in the field of microplastics. Professor Tagliabue and Ms Dall'Aglio have significant experience in building Raman microscope

systems and have collaborators specializing in low-cost systems. Thus, this project is achievable in the time scale available.

Deliverables

1. An assessment of the state-of-the-art low-cost Raman microscope systems available.
2. A functioning Raman microscope that can be used on a future Sailowtech cruise.
3. A written report presenting the results and work accomplished during the project.
4. An oral presentation at the end of the semester to present the results of the project.
5. A document explaining how to build the device to make it reproducible.

Documentation

Here is the link of last semester's project:

https://github.com/Sailowtech/Open-Raman/blob/main/Reports%20and%20Presentations/Report%20RamanSpectrometer.pdf

Planned interaction with Sailowtech

The aim of this project is to fabricate a device that can be used on a Sailowtech cruise. Consequently, there will be several meetings with Sailowtech (about 3/4 in the semester) to follow the progress of the project and to assess additional requirements for remote measurement (e.g. maximum power the spectrometer can use, its robustness to vibrations etc...). In addition, you will be counted as a member of Sailowtech, and will therefore be able to take part in the various activities and potentially test the device during one of our expeditions.

Contact

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