

Hong Kong Student Science Project Competition 2022

Template of Extended Abstract (Invention)
(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: JABC222

Project Title: AI UV-VIS Mobile Spectrometer

Project Type: Invention

To our best knowledge and after thorough literature research, as at __30 / 06 __ / 2022 __ , there are / are no* similar works. If there are, the reference links are as below:

The enhancement our project has made for the existing related products or research is summarized as below:

***Please delete if not applicable. HKSSPC values the originality of works. Students must conduct literature research thoroughly to ensure that their works are unique, and to list relevant reference materials to complement the research or invention.**

I. Background

Plastics and water pollution crisis in Hong Kong has continued to worsen (Db, 2017), and is rapidly spreading across the globe. People are worried that the drinking water can be toxic because it might contain plastics and other pollutants in it. Such pollutants are harmful to animals and human beings, and can damage the environment. Many sea animals and creatures start to extinct due to pollution (Reddy, 2018). Spectrometers are one of the most useful devices to monitor water quality. Commercial spectrometers are usually expensive, large, single-functioned and not user-friendly. Furthermore, most of them in the market only equip one or two functions. It may hinder many junior scientists from conducting environmental investigations regarding plastics and pollutant concentration. With our low- cost multi-functional spectrometer, we hope to facilitate more environmental investigations.

II. Objectives

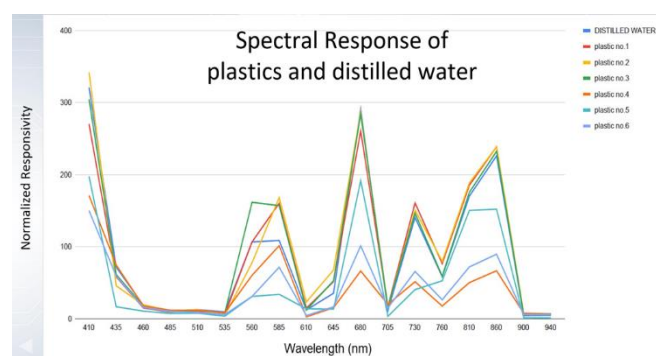
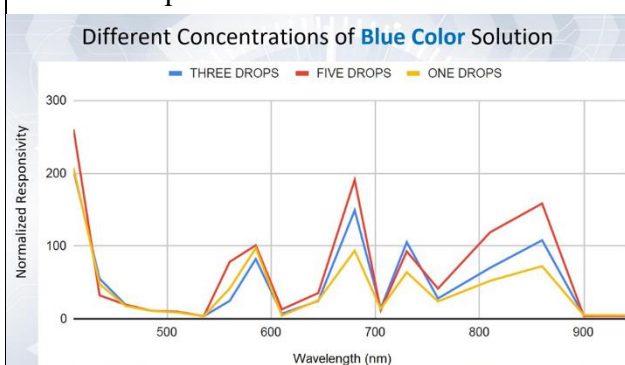
The aim of this project is to monitor and collect data regarding pollutants and water quality by detecting plastics and pollutant concentrations using our self-designed AI UV-VIS Mobile Spectrometer connected to a small Raspberry Pi computer system. It can be used by concerned parties, such as environmental protectionists, junior scientists, health concerned parties and school students. Concerned parties can use the results to monitor water quality and pollution levels, and make claims to the government agencies for remedial measures.

III. Methodology

Firstly, this spectrometer detects the lights of 18 different wavelengths in the ultraviolet (UV), infrared (IR) and visible light (VIS) domains shone on the sample. They are reflected or transmitted through the sample and detected by the UV-VIS / IR spectroscopy sensors (ATA Scientific, 2020). By comparing with the signals from a blank sample, it can find the amount of light absorbed by the materials at different wavelengths. Secondly, a HuskyLens is also attached to the Raspberry Pi computer system to recognise and sort plastic wastes by programming the HuskyLens.

IV. Design of Invention

Our self-designed AI UV-VIS Mobile Spectrometer is a small portable device that can detect visible (VIS) light and ultraviolet (UV) light spectrum ranges of measurements. It can detect plastics in both water and air, and pollutant concentrations. The device is coded to process digital data, which can be shown automatically in graphical forms and the data can be downloaded onto other computers. The most useful feature is that this spectrometer uses a Raspberry Pi computer system, which applies the artificial intelligent functions, such as object recognitions using a HuskyLens to detect, sort and separate plastics wastes. Together with a user-friendly platform, this self-designed AI UV-VIS Mobile Spectrometer includes the self-coded software to generate graphs that can show results instantly and concisely. It is definitely ready to contribute in the field of environmental protection research for quantitative and graphical analysis at a low cost. We have done experiments using our self-designed AI VIS-UV Mobile Spectrometer. The spectrometer detected plastics in both air and water, including polyethylene terephthalate (PET), high-density polyethylene (PE-HD), low-density polyethylene (PE-LD), polypropylene (PP), polystyrene (PS) and other plastics (O) (Howard, 2021). We tested various colored solutions in different concentrations as well. In order to test the accuracy of our spectrometer, we have used sample specimens as a control. The results in Figures show systematic and consistent quantitative data.



V. Application / Market Need

There are some spectrometers in the market which also have visible light and ultraviolet light spectrum ranges of measurements, such as Hach DR 6000TM Spectrometer or Vernier Spectrometer. They have similar basic functions; e.g., measure objects, liquids or light in both visible light and ultraviolet light spectrum ranges, but they are more expensive. However, our self-designed spectrometer only costs HK\$2344, which has more value for money and functions. Furthermore, Raspberry Pi computer system is more expandable with artificial intelligent functions, such as text-to-speech, when compared with other commercial spectrometers available on the market. Artificial intelligent functions may be able to help the users who have reading difficulties. Table 2 shows the comparisons of different models of spectrometers.

VI. Conclusion

Our self-designed AI VIS-UV Mobile Spectrometer is produced at a very reasonable cost with a user-friendly platform. It includes a self-coded software to generate graphs that can show results concisely and rapidly. It is a small size and easy-to-carry device for many junior scientists to conduct environmental investigations regarding plastics and pollutant concentration. This low-cost multi-functional mobile spectrometer is able to facilitate more environmental investigations.

✖ Our project is developed based on our school's previous project and the enhancement is as below:

