Project	MONOCLE H2020 (grant 776480)	**Start / Duration**	1 February 2018/ 48 Months
Dissemination	PUBLIC	**Nature**	OTHER
Date	26/2/2019	**Version**	1.0

MONOCLE

Multiscale Observation Networks for Optical monitoring of Coastal waters, Lakes and Estuaries

Deliverable D2.3

MONOCLE sensor integration materials

Project Description

Funded by EU H2020 MONOCLE **creates sustainable *in situ* observation solutions for Earth Observation (EO) of optical water quality in inland and transitional waters.** MONOCLE develops essential research and technology to lower the cost of acquisition, maintenance, and regular deployment of *in situ* sensors related to optical water quality. The MONOCLE sensor system includes handheld devices, smartphone applications, and piloted and autonomous drones, as well as automated observation systems for e.g. buoys and shipborne operation. The sensors are networked to establish interactive links between operational Earth Observation (EO) and essential environmental monitoring in inland and transitional water bodies, which are particularly vulnerable to environmental change.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776480

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1. Scope

This report lists materials used and / or developed in MONOCLE for the integration of sensors and components with measurement platforms, with specific focus on mounts to equip Remotely Piloted Aircraft systems (RPAs or 'drones') with suitable cameras. Where possible, 3D printable sensor mounts are provided for public use. For each set of materials, details are described in relation to relevant documentation, necessary parts, manuals and plans in order to print and use the sensor mount.

This release of sensor integration materials is intended to support field work during the first half of the project, in MONOCLE as well as any aligned projects or activities, which is why a number of non-RPA designs are also included. Most designs are likely to evolve further during the project. Deliverable 2.5 "MONOCLE low-cost sensors support package" is planned for project month 30 (expected July 2020) and will include the mature version of designs intended for low-cost manufacturing and sensing.

2. Integration materials

2.1 Ocean Optics STS-VIS onto a DJI Phantom

Manufacturing instructions:	3D-print (see URLs included)
License:	CC BY-SA 4.0 https://creativecommons.org/licenses/by-sa/4.0/

These mounting brackets are intended to house an Ocean Optics spectrometer (with lens), a Raspberry Pi 3 miniature Linux controller, and a battery on a DJI Phantom, aiming for balance in weight distribution. Existing 3D-printed mounting brackets were available at £10 and found to break easily, so a solution was designed from scratch.

The main mounting brackets (for a battery and the STS-VIS, respectively) are published under a Creative Commons Attribution-ShareAllike licence and can be found at: https://www.thingiverse.com/thing:3420980. The Raspberry Pi case was adapted from an existing open source design (https://www.thingiverse.com/thing:410003) and can be found at https://www.thingiverse.com/thing:3420984.

The main housing for the STS-VIS is shown in Figure 1. 3D-renders of the individual components are shown in Figure 2.

Figure 1 Mounting bracket for the STS-VIS attached to the DJI Phantom

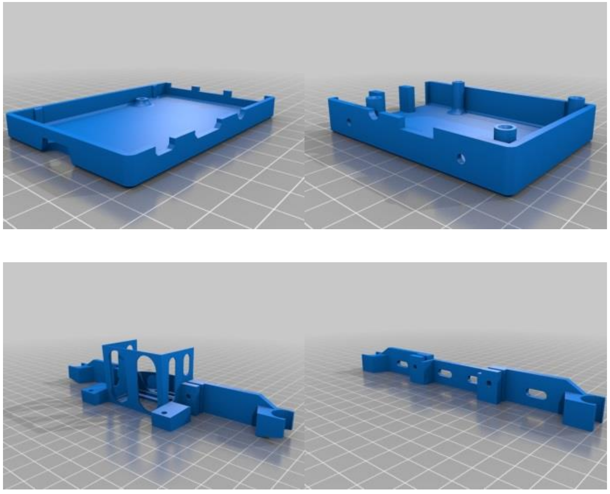

Figure 2. 3D render of the components (top row: Raspberry Pi case. bottom row: sensor and battery bracket)

2.2 Mini-secchi disk

Manufacturing instructions:	3D-print See Brewin et al. 2019 (https://doi.org/10.3390/s19040936)
License:	CC BY-SA 4.0 https://creativecommons.org/licenses/by-sa/4.0/

In addition to materials developed in MONOCLE, the project will be testing the citizen science-ready and 3D-printable mini-secchi disk developed by PML. Designs and materials were made available to MONOCLE in the first test campaign and have recently been published (Brewin et al. 2019). Wider dissemination, testing and re-use of the design are encouraged by the authors. The 3D-printable designs are included as supplementary documents with the aforementioned paper, which is available open access at https://www.mdpi.com/1424-8220/19/4/936 (doi: 10.3390/s19040936). Figure 3 shows an exploded design and render from the paper, for reference. It is expected that the disks will be trialled in all future MONOCLE validation campaigns.

An instruction sheet developed for the Loch Leven field campaign in August 2018 is also provided with this deliverable, as shown in Figure 4 below.

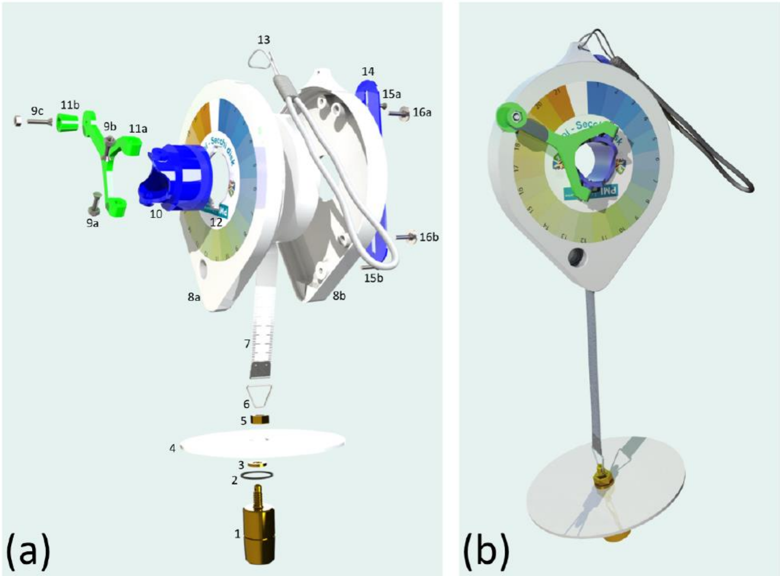

Figure 3. An exploded drawing (a) and rendering (b) of the mini-Secchi disk. Numbers refer to components as follows: 1. Weight; 2. Weight O-ring; 3. Weight washer; 4. Secchi disk; 5. Weight bolt nut; 6. Weight attachment circlip; 7. Tape measure; 8a,b. Mini-Secchi casing; 9a,b,c. Fixings; 10. Bobbin; 11a,b. Handle; 12. Colour scale; 13. Lanyard; 14. Finger strap; 15ab, and 16a,b Fixings.

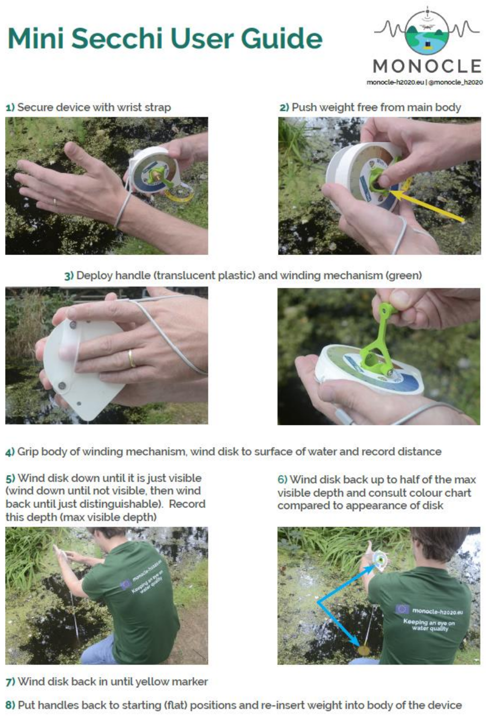

Figure 4. User guide for the mini-secchi disk.

2.3 Multispectral Micasense RedEdge-M camera for DJI Phantom 4 pro

Manufacturing:	3D-print
License:	CC BY-NC 4.0, subject to Terms of Use included with the designs
Reference:	Strackx, Gert. (2019). 3D prints integration MicaSense RedEdge under DJI PH 4 pro. http://doi.org/10.5281/zenodo.2578108

The MicaSense RedEdge-M is a multispectral camera which can be integrated unto different RPAS platforms (https://www.micasense.com/). This camera captures spectral information in the Visible (VIS), Rededge an Near-Infrared (NIR) region, which makes the sensor suitable for a wide variety of applications, including water quality monitoring. The Micasense is delivered together with a small light sensor.

An integration kit was created which assures platform stability and flight safety during operations. The components are shown in Figure 5. The 3D-printable designed of the individual components are included with this deliverable in a single zip archive. These prints are freely available for interested users. The final outlook of the result is depicted in Figure 6.

Figure 5 Materials needed to integration the MicaSense RedEdge-M under the Phantom DJI 4

Figure 6 Final result of the integration of the MicaSense RedEdge-M under the Phantom DJI 4 pro.

2.4 iSPEX mount for sensor on smartphone

Manufacturing instructions:	pending final design review
License:	not yet applicable

The iSPEX mount consists of three parts: the optical tube, smartphone clip, and smartphone backplate. The optical tube is universal to all devices, and the smartphone clip is universal to all smartphones. The backplate is custom-designed for each smartphone model, to account for differences in shape and camera location. The final design is, however, still under review and the aim is to support a wide range of phone models from the start.

Stills from the present design are included in Figures 7 and 8. The phone model-specific backplate is shown in green. Green bars extending from the backplate in Figure 8 may differ between smartphone models, while the rest of the design is the same.

The final release of designs to support the iSPEX on a wide range of devices will be part of D2.5 “MONOCLE low-cost sensors support package”.

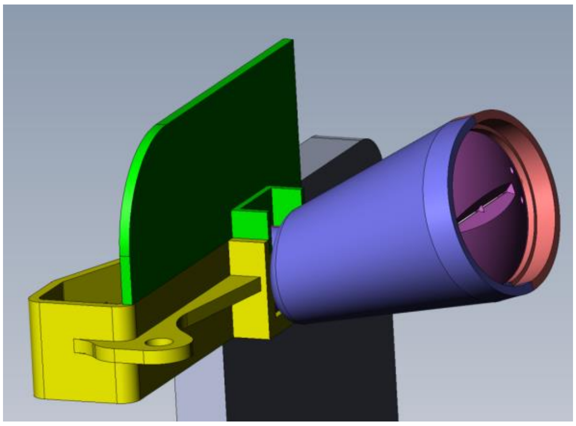

Figure 7: Side view of the new iSPEX module on an iPhone SE. The smartphone camera is located under the optical tube (purple+red).

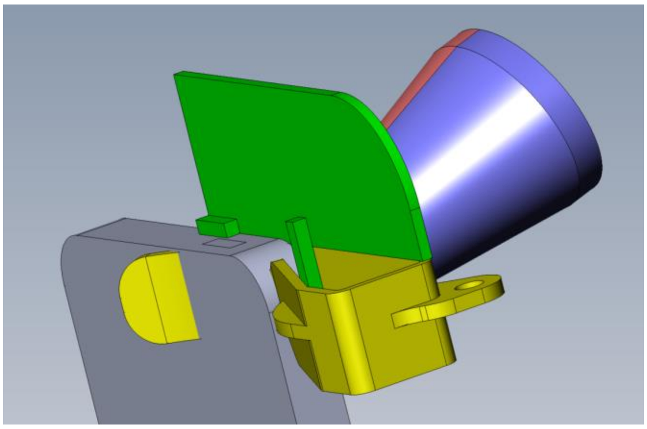

Figure 8: Front view of the new iSPEX module on an iPhone SE. The phone screen faces the user. The clip (yellow) stretches over and clamps onto the phone screen.

References

Brewin, R.J.W., Brewin, T.G., Phillips, J., Rose, S., Abdulaziz, A., Wimmer, W., Sathyendranath, S., Platt, T. (2019). A Printable Device for Measuring Clarity and Colour in Lake and Nearshore Waters. Sensors 19(4), 936. doi: 10.3390/s19040936