Development of a cost-effective IoT hyperspectral device for distributed and autonomous monitoring of vine crops

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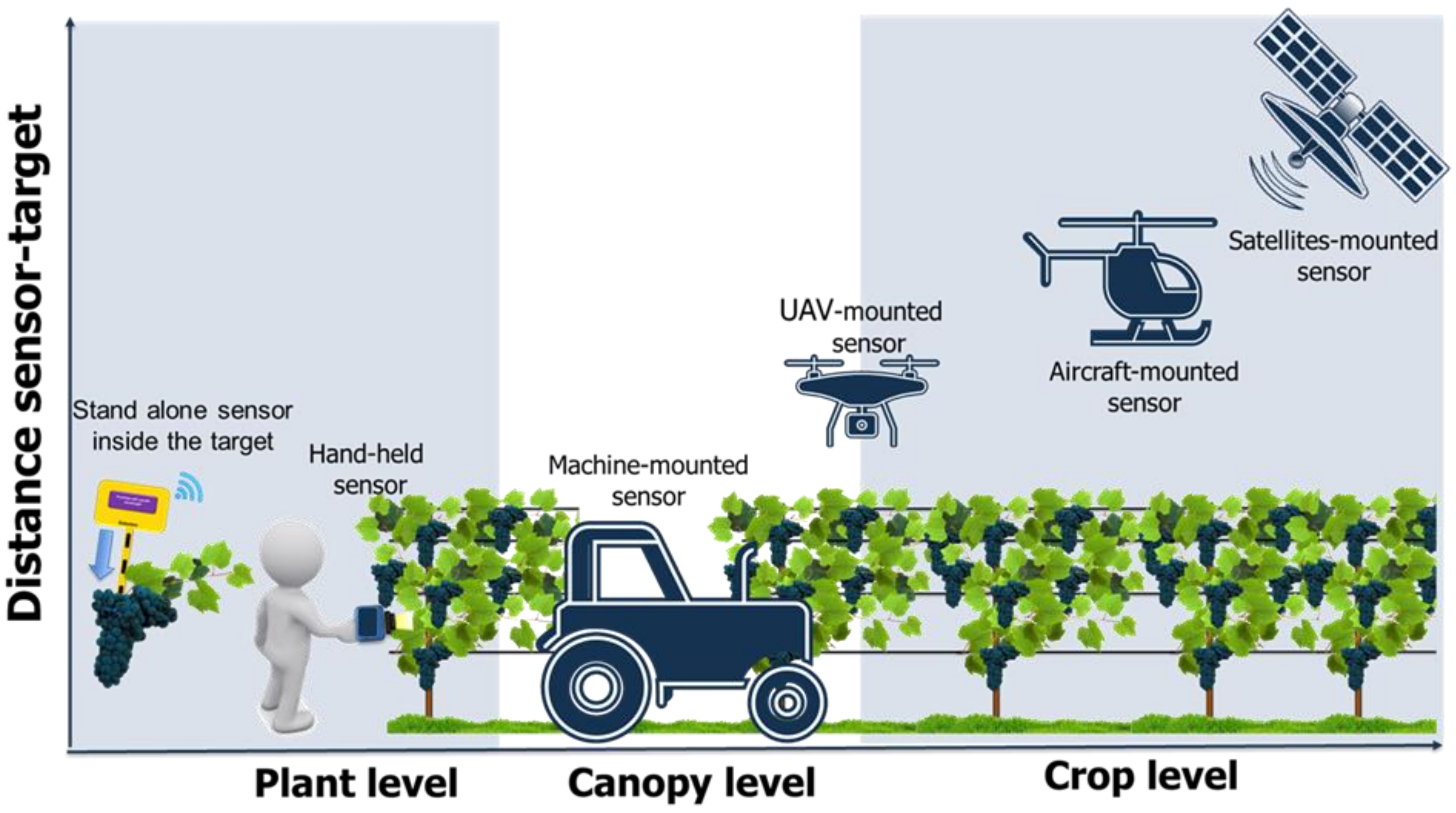
INTRODUCTION

Nowadays, the wineries' **trend is to bring the laboratory in field** (**figure 1**). **Despite remote sensing (RS) is a landmark for the current agricultural sector, the latter has not been capable to fully embrace this technology in many real production circumstances**). Indeed, vineyards represent a real challenge for the application of RS technologies. This is due to the discontinuous nature of grapevine canopies and their moderate cover which causes noisy backgrounds and shadows influences on the measured reflectance signals. **Thus, the use of proximal sensing (PS) is still a convenient option**. **The consumer electronics industry** is driving the convergence of digital circuitry, wireless transceivers, and micro electro-mechanical systems (MEMS), which makes it possible to integrate sensing, data processing, wireless communication, and power supply into low-cost millimeter-scale devices. This **is leaving space to a completely new method of data acquisition and management using wireless sensor networks** (WSNs) based on small battery-powered nodes.

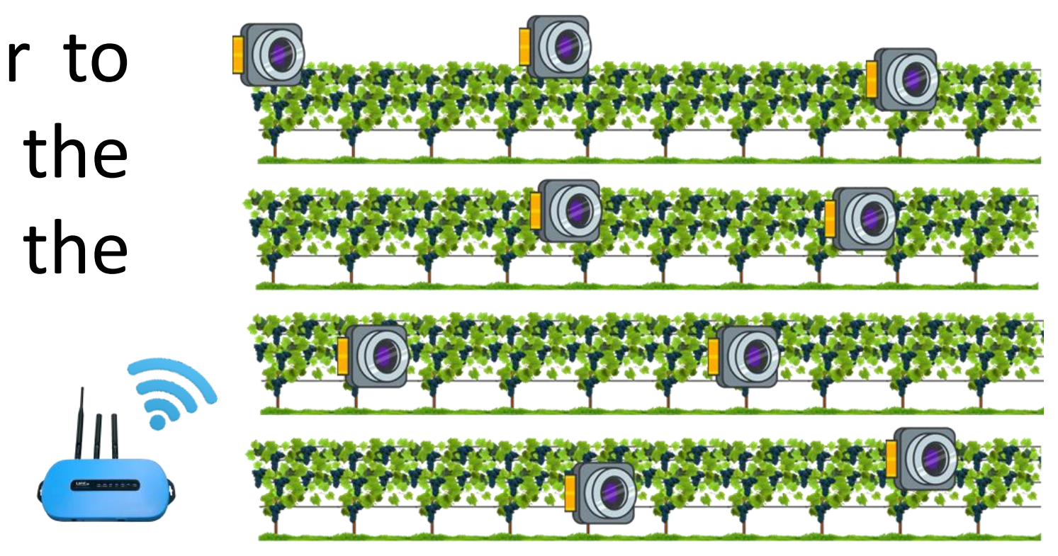


GOAL

The general objective is to **design, build and test a miniaturized and inexpensive hyperspectral imaging device** in order to develop a network of distributed sensors to be placed in proximity of the grapevines. The images will be correlated with the conventional analyses in order to build predictive mathematical models to estimate water and phytosanitary status of the monitored parcel.

Detect infections *Water status*

Advantages: Cost, increase control points and continuous monitoring in real time

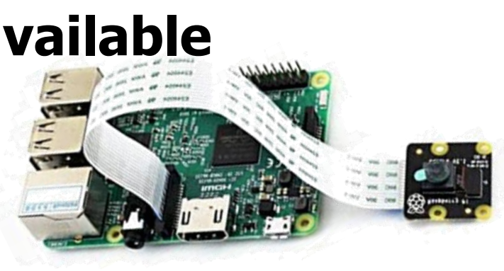


MATERIALS & METHODS

Components

Commercially available


Holographic diffraction grating


Raspberry Pi 3 B+

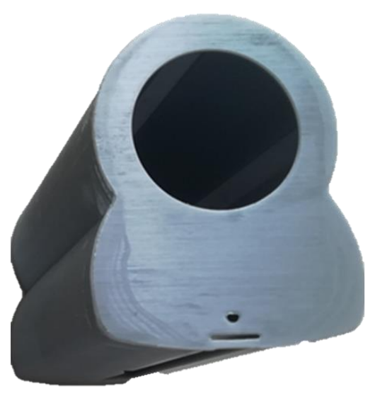

Macro 52 mm lens


Raspicam NoIR


Front lens

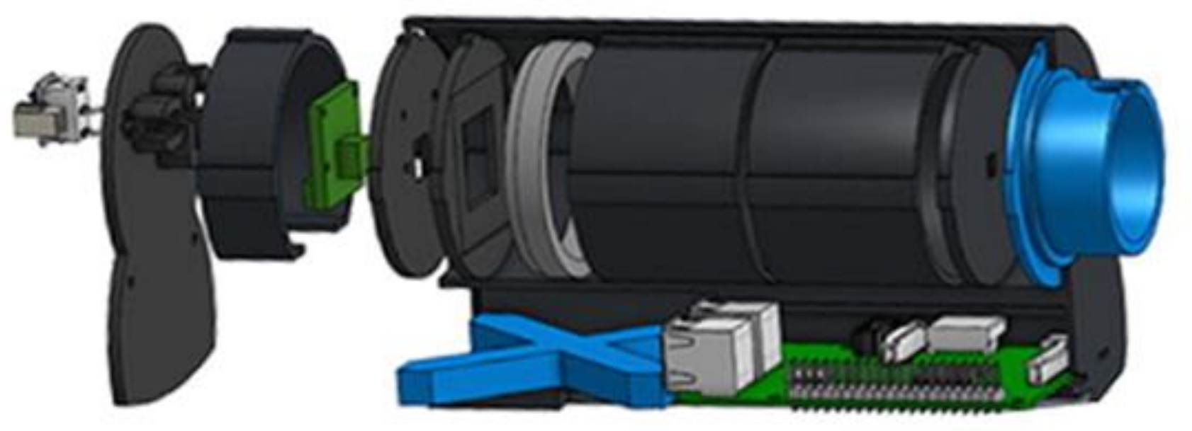
Manufactured


Spacers

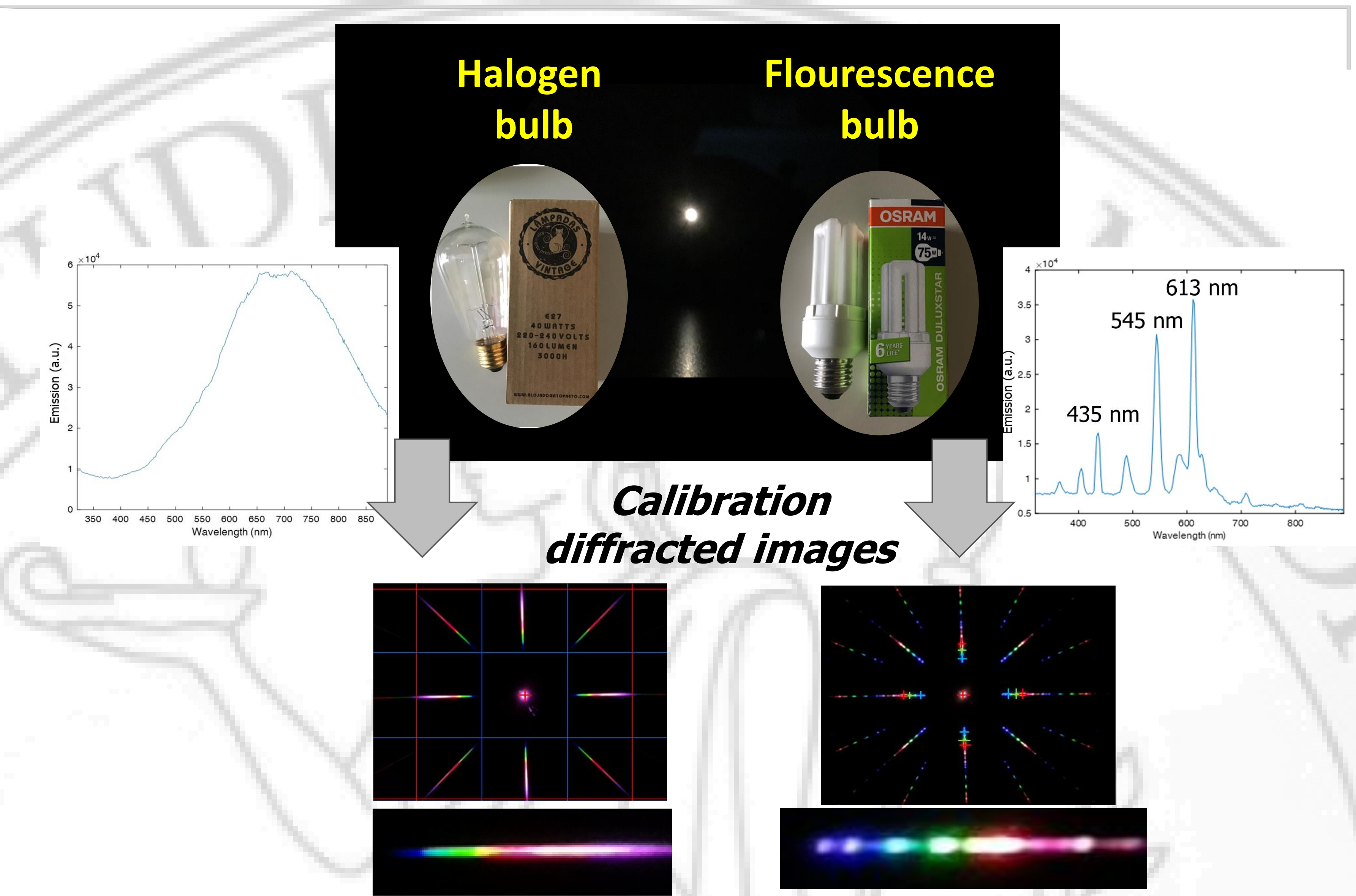

Case


holders and connectors

Overall cost about 500€



Calibration

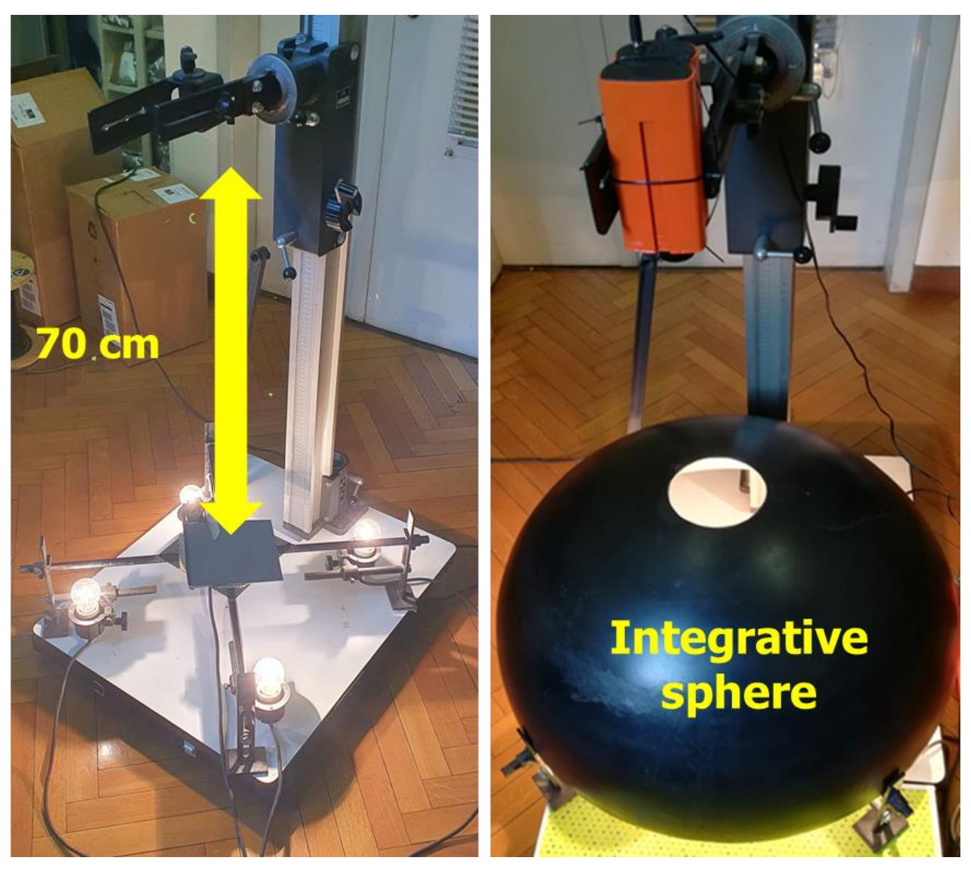


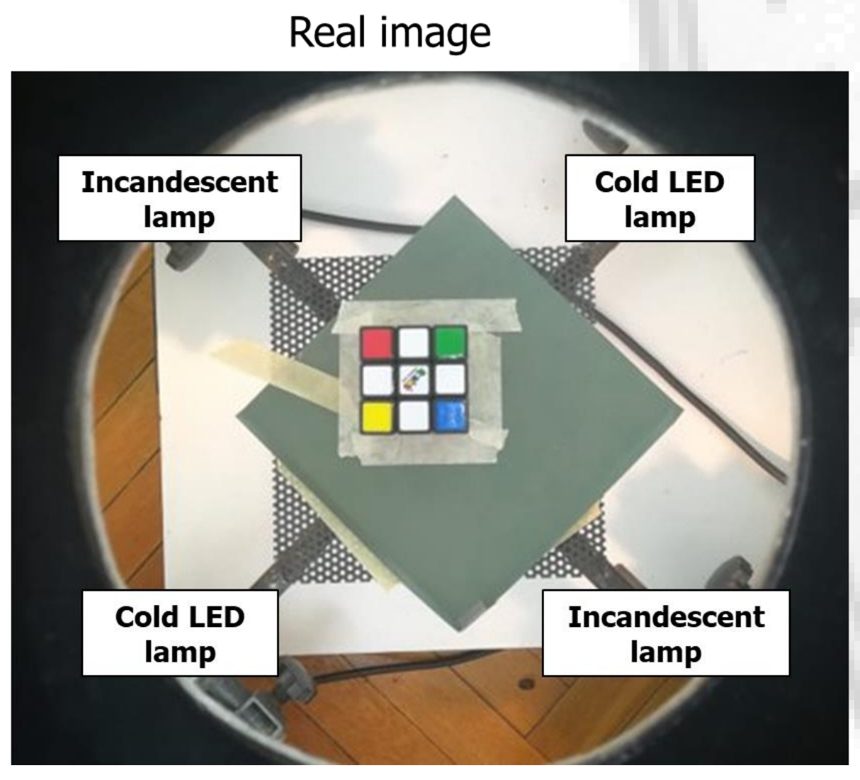
Calibration diffracted images

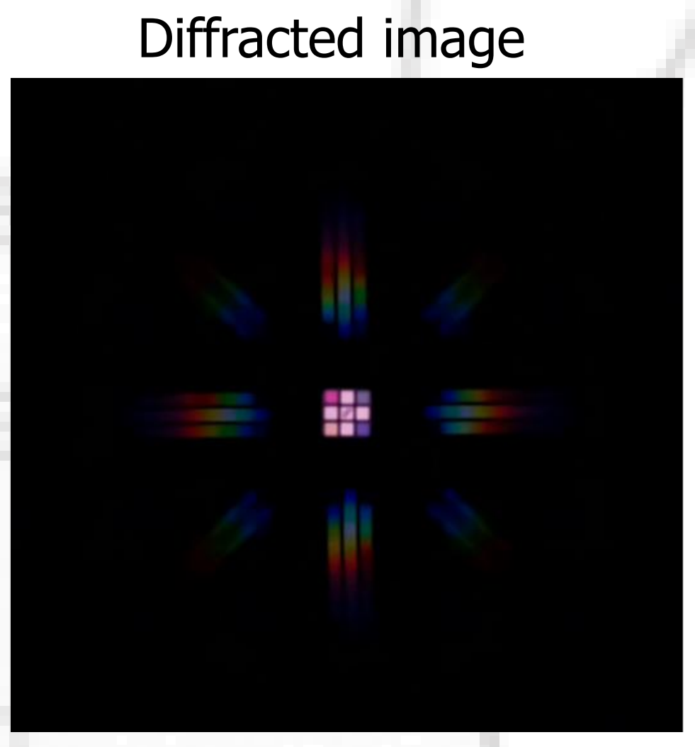
Spectral limits:
- Blue lines → inner limits
- Red lines → external limits

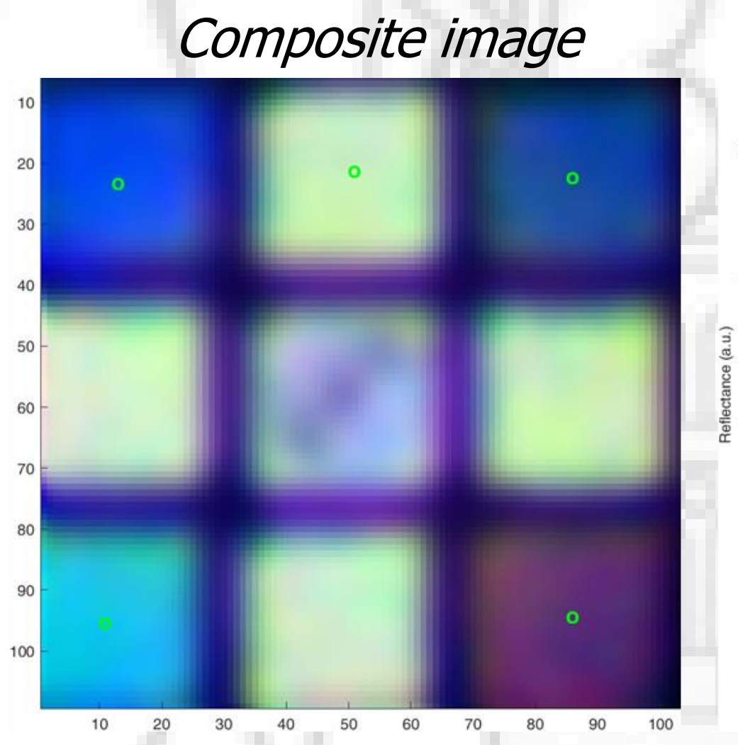
Peaks wavelength:
- Blue → 435 nm
- Green → 545 nm
- Red → 613 nm

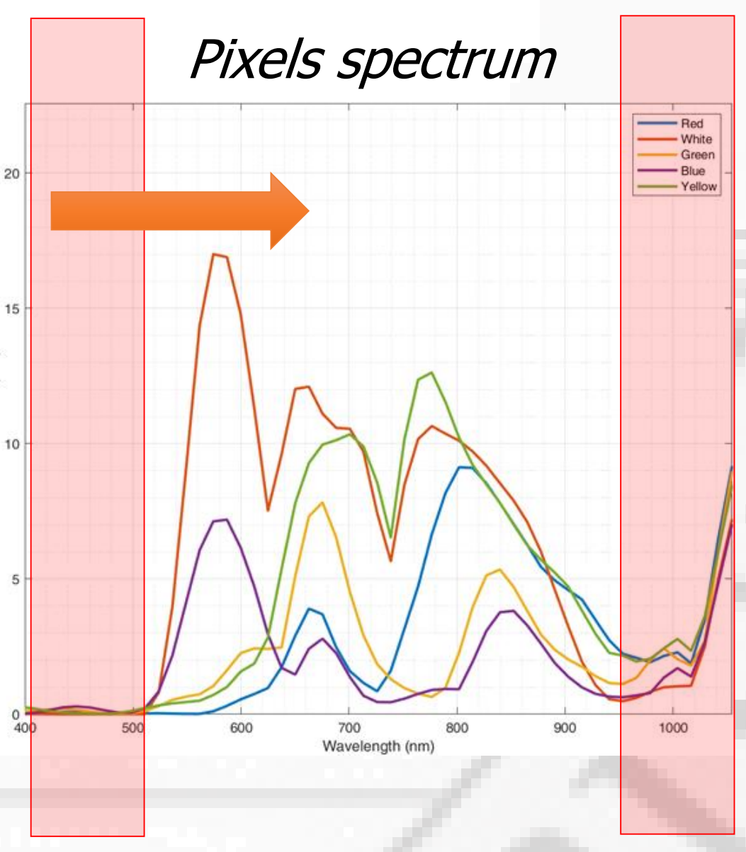
RESULTS











The final result is a spectral output which depends on the intensity of the environmental light and the sensitivity of the image sensor. Obviously, higher is the light reflected from the Rubik's cube higher is the magnitude of the relative spectrum. However, a shift about 100 nm is noticeable taking into account the real emission of the blue (around 450nm), the green (around 530nm) and the red (around 650nm) suggesting a non-perfect calibration of the camera.

Work in progress
0% 100%

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beyond spectral range

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