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► To cite this version:

Antoine Moutenet, Julien Serres, Stéphane Viollet. Comparison between skylight polarization in visible and ultraviolet spectra for heading measurements. Journée des Jeunes Chercheurs en Robotique (JJCR 2023), GDR Robotique; Franck Ruffier; Maan El Badaoui El Najjar, Oct 2023, Moliets et Maâ, France. hal-04519955

HAL Id: hal-04519955

<https://hal.science/hal-04519955v1>

Submitted on 25 Mar 2024

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Comparison between skylight polarization in visible and ultraviolet spectra for heading measurements

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Keywords: Ultraviolet (UV), skylight polarization, Rayleigh scattering, celestial compass, polarized vision.

In the field of autonomous outdoor navigation, the calculation of a precise heading is essential. For more than one century, numerous studies have been carried out on the ability of navigating insects, such as desert ants *Cataglyphis fortis* [1], to find their bearings thanks to the polarization of light scattered by the atmosphere [2] (Fig. 1, left). In space, the sunlight is naturally unpolarized, however, it is scattered by atmospheric molecules, and then becomes polarized according to a very precise pattern seen from the ground. This make it possible to find the sun's position, even if the sun is hidden [3]. Although it has already been possible to build celestial compasses based on this polarization phenomenon, it tends to be corrupted in the visible spectrum on overcast days, limiting their use [4]-[11].

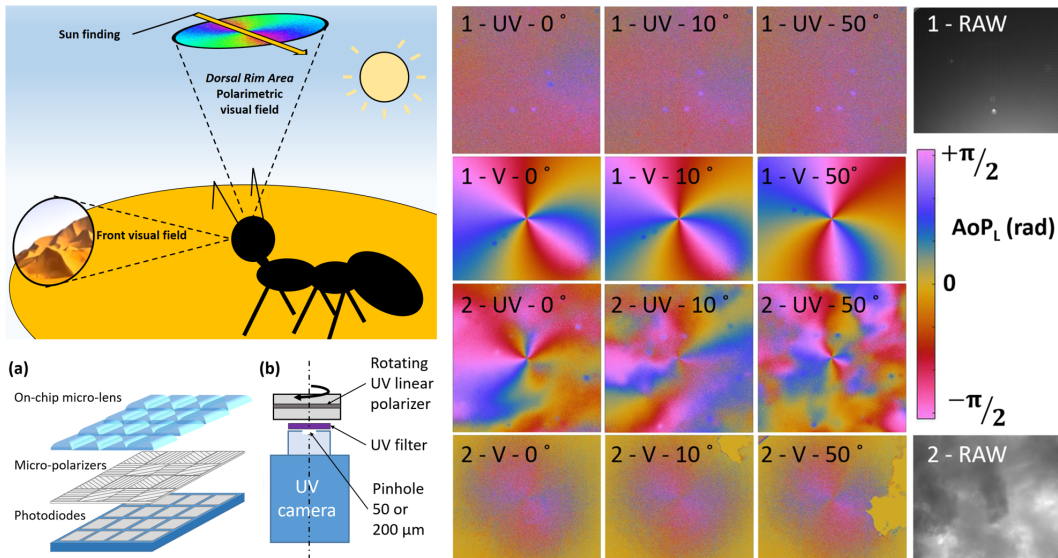


Figure 1: From left to right: The visual field distributions of a desert ant to navigation. Two cameras used for our measurements, one working in the visible range (a) and another one in the UV range (b). Examples of polarization angle patterns (AoP_L) measured. 1 & 2 correspond to clear and overcast skies, respectively. Visible and UV measurements are marked V and UV, respectively, angles in degrees correspond to different camera orientations.

However, still relying on insects which initially inspired us, we can see that they are sensitive not only to visible light polarization, but also to ultraviolet polarization [1], which could be the key to navigating under overcast skies using polarimetry [4]-[8]. We therefore decided to setup a UV polarimetric camera (UV-sensitive camera with a rotating UV linear polarizer and an objective directly mounted onto it, composed of a UV-centered band-passfilter and a pinhole of $50\mu\text{m}$ or $200\mu\text{m}$), because it was not commercially available, and to compare its levels of performance with a conventional visible polarimetric camera (polarized monochromatic camera), under different weather conditions (Fig. 1, right).

Our preliminary results with our UV-sensitive camera in overcast conditions are not yet as good as those we get from our visible camera in clear conditions, notably because of the very long integration time intrinsic to the UV-sensitive sensor's rusticity. Despite mixed results, this study does demonstrates the advantage we can get by looking into this new type of sensors.

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