Improving Accessibility for Deep Sky Observation

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Electronically Assisted Astronomy allows to generate in near real time enhanced views of deep sky objects like nebulae and galaxies. This approach is ideal for people who have difficulty with direct observation through a telescope, especially those who have poor visual acuity or physical difficulties to position oneself correctly in front of the instrument.

Electronically Assisted Astronomy is widely applied today by astronomers to observe planets and deep faint sky objects like nebulae, galaxies, or globular clusters. By capturing images directly from a telescope coupled to a camera, this approach allows to generate enhanced views of observed targets that can be displayed in near real time. While astrophotography aims at producing detailed and visually appealing images after numerous hours of post processing of long exposure images [1], Electronically Assisted Astronomy aims at quickly getting images by stacking on-the-fly raw images in order to accumulate the (faint) signal (and then reduce the inherent noise). All this is made possible by the fact that recent CMOS/CCD cameras are extremely sensitive and have a very low read noise (i.e. amount of noise generated by electronics) [2] -- which makes it possible to obtain already satisfactory results with lightweight image processing.

By comparing with direct visual observation through an eyepiece and an instrument (refractor or reflector), this approach has definite advantages for people who have physical constraints preventing from enjoying astronomy to the fullest: poor eyesight requiring the wearing of glasses (in particular for people with astigmatism), difficulties in positioning to look through the eyepiece of a telescope, etc. Not to mention the fact that most people cannot see colours during visual observations (with a few exceptions, the light from deep sky objects is too weak for the colour to be visible), making deep sky observing sessions frustrating for a novice.

Electronically Assisted Astronomy also makes also possible to observe in difficult outdoor conditions, for example in places heavily impacted by light pollution. Deep sky objects almost invisible in the eyepiece of an urban or suburban sky become impressive and detailed.

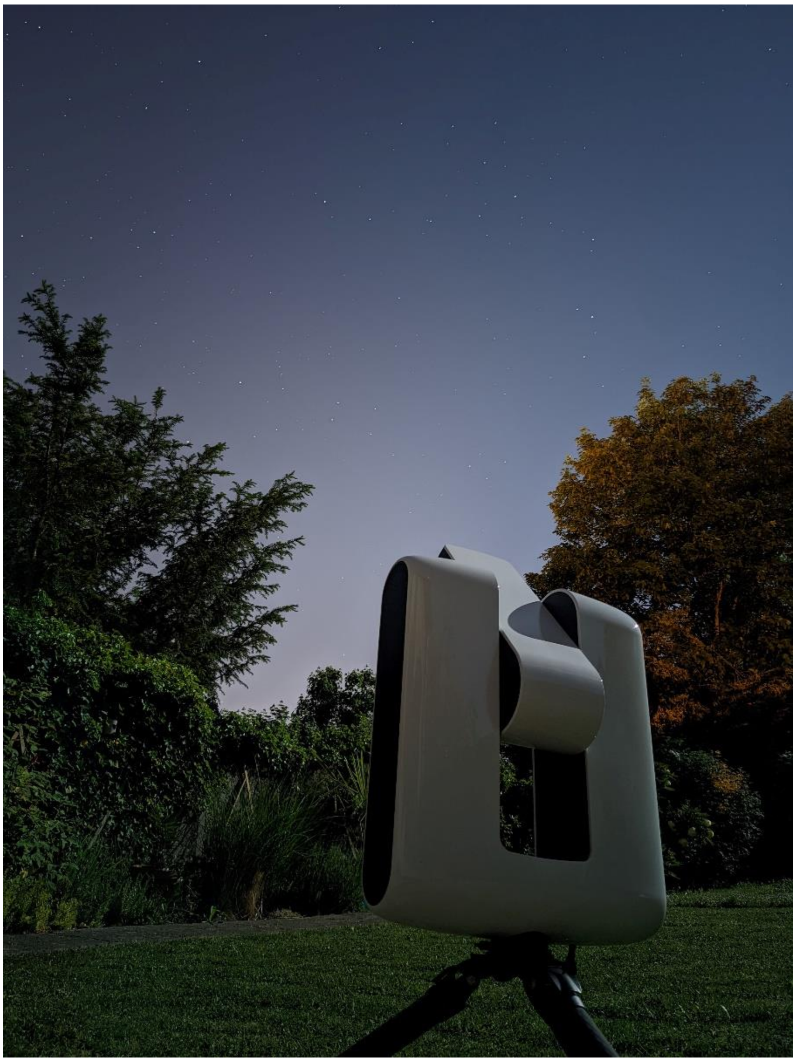

Figure 1: live session of Electronically Assisted Astronomy on the night of the 14 May 2022 from a village in the northeast of France.

Nevertheless, the practical implementation is not straightforward. In fact, Electronically Assisted Astronomy requires a complex hardware setup [L1]: motorized alt-azimuthal or equatorial mount for tracking targets (w.r.t the Earth's rotation), refractor/reflector with good-quality lens, CMOS/CCD dedicated cameras, pollution filters, etc. Depending on the size of the targets, a Barlow lens (for planets and planetary nebulae) or a focal length reducer (for large nebulae) is also required. Moreover, dedicated software like Sharpcap or AstroDMX are needed to control the camera and then deliver the live images on a display device [L1].

The easiest way to get rid of these difficulties to observe the deep sky is to use a remote telescope. Using a simple web interface, it is possible to control telescopes located at the other end of the planet (which can be interesting for viewing deep sky objects only visible from another hemisphere) [L2]. Nevertheless, this mechanism is not very suitable for live observation -- the idea being rather to retrieve the images a few hours later.

During the MILAN research project (MachIne Learning for AstroNomy), funded by Luxembourg National Research Fund, we use instruments provided by our partner VAONIS [L3] to collect images of deep sky objects. VAONIS provide fully automated telescopes that are controlled via smartphones & tablets. With these telescopes, all the critical steps are automatized and transparent for the end-user: tracking, focus, capture, lightweight image processing, and then display.

Figure 2: image of the M5 globular cluster (distance from Earth: 24 460 light years), as seen on the night of the 9 May 2022 from a village in the northeast of France. 125 raw images of 10s exposure-time were stacked in near real-time to obtain this result.

Electronically Assisted Astronomy allows us to plan and organize observation sessions without most of the technical barriers mentioned earlier. For the time being, we can capture and visualize live images in different conditions (e.g., low or high light pollution) and with different parameters (exposure time and gain for each unit shot) to build a collection of images while controlling the results in live. In a near future, we plan to participate in events for the general public in Luxembourg and in the Greater Region in order to make young and old discover the beauties of the deep sky.

Links:

[L1] https://agenaastro.com/articles/agena-beginners-guide-to-choosing-equipment-for-deep-sky-eaa.html

[L2] https://telescope.live

[L3] https://www.vaonis.com

References:

[1] Parker, Greg. “Making Beautiful Deep-Sky Images”. Springer, 2017, doi:10.1007/978-3-319-46316-2

[2] Qiu, P., Zhao, Y., Zheng, J., Wang, J. F., & Jiang, X. J. (2021). “Research on performances of back-illuminated scientific CMOS for astronomical observations”. *Research in Astronomy and Astrophysics*, *21*(10), 268. doi:10.1088/1674-4527/21/10/268

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