

Towards a network of amateur astronomers relying on an innovative telescope

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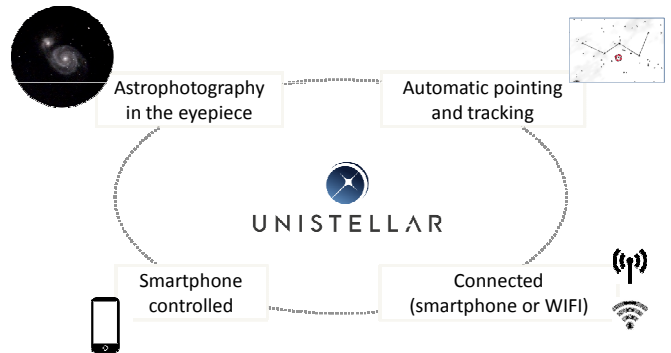
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ABSTRACT: As soon as a new object is detected, it is important to collect as many observations as possible. Amateur astronomers should be given a paramount role for this task: they are split all over the world and eager to participate in such a global effort. Here, we describe an innovative design for an enhanced-vision telescope that will make astronomy more popular and more participative. The scope can work in two modes, i) as an ordinary scope operated by the observer ii) in an automatic way, pointing in a given direction in the sky thanks to its field recognition algorithm and tuning the image recording parameters to provide optimal image quality for refining the orbit of newly discovered objects. Through this operating mode, the amateur observer can still be looking at the sky through the scope eyepiece but s/he will not be in charge of its running. The goal is to create a worldwide network of smart and connected telescopes. Potential observers will receive alerts requesting to observe a given region of the sky at a given time. This scenario will guarantee that relying on amateur astronomers does not hamper the quality of the observations needed to refine the orbit of any newly discovered NEA, all the while allowing the inexperienced user to witness the event he is collecting data for, thus promoting citizen science among the general public.

Context

- It is of prime importance to quickly collect observations of a newly discovered object
 - To confirm or not that the object is not already registered
 - To improve its orbit determination
 - If it happens to be a NEO, update the impact probability calculation
- Amateur astronomers are available worldwide and eager to collaborate with professionals
- Asteroid tracking presents a dual education/planetary defense interest and is thought ideal for such a collaboration
- A network of identical telescopes that provide, together, an initiation to astronomy and a easy-to-use tool for asteroid tracking will be of interest for both education and planetary defense

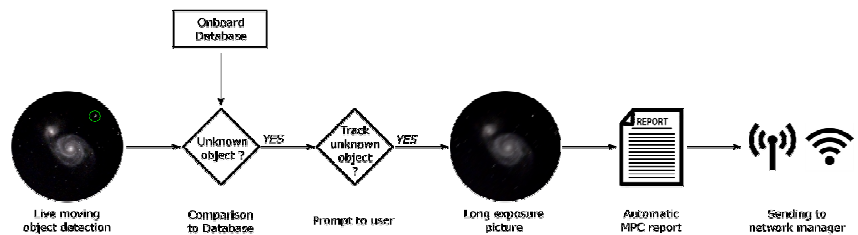
Enhanced Vision Telescope



Operating mode 1 – Amateur astronomy

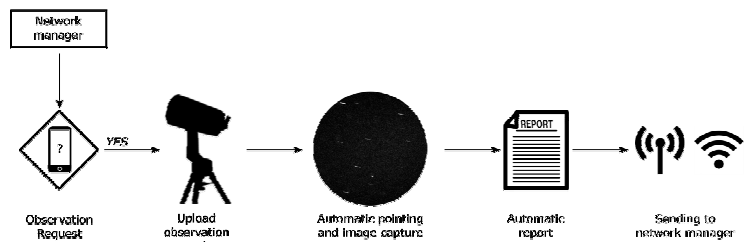
All the standard functions of high-end amateur telescopes are available and include an innovative live object detection:

- Automatic recognition of moving objects
- When a moving object is detected, the observer is prompted to trigger the *object tracking mode*
- Identification of these objects by comparison to a database (downloaded in advance from a professional ephemeris server, IMCCE for instance in France)
- If the object does not match with any in the database, the observer is informed and a MPC observation report is automatically generated and sent via the smartphone connection or WIFI



Operating mode 2 – Asteroid follow-up mode

- Heritage from the TAROT system (<http://tarot.obs-hp.fr/infos/>)
- The network manager sends an observation request for a target of interest (NEA, comets,...) to all eVscope users on their smartphone
- If the user agrees to participate, the observation procedure is uploaded to the telescope and it automatically points and captures images of the requested target
- No action from the observer is needed with the exception of ensuring that all the necessary resources (e.g. visibility, stability, power, network) are available
- Observation data are stored in the scope computer and sent to the network manager in near real time through smartphone connection or WIFI
- Suggestion: One manager per country / language community coordinated by IAWN (International Asteroid Warning Network)



Conclusion & Future Work

- Our network would be supported under partnerships with ESA SSA programme in Europe and the SETI Institute in the US. Additional partners in Asia will be of interest.
- A first optimal implementation could focus on regions with observing gaps like the Southern Pacific (French Polynesia) and Southern Indian (Mascarene Islands)
- Unistellar company will deliver its first scopes in the second semester of 2018, retail price \$1000-1500.

About UNISTELLAR

Unistellar is a start-up company that develops the first enhanced vision telescope. It is an affordable portable, connected and easy-to-use telescope which aims at making astronomy more popular as well as encouraging citizen science among the general population. Its smart optical construction allows the inexperienced user to witness the event for which he is collecting data all in real time. Unistellar plans to sell thousands of telescopes within 2020, thus effectively creating a dense worldwide network of connected telescopes available for scientific observation campaigns. Pre-sales will be available in summer 2017 on a crowdfunding platform. [More information: www.unistelloptics.com](http://www.unistelloptics.com)

Enhanced Vision Telescope features

- 4.5-inch mirror
- Color camera
- < 3 arcsec resolution
- ≈30 arcmin field of view
- Max magnitude
 - >18 in long exposures (100s)
 - >13 in short exposures (1s)
- Integrated GPS



Example pictures

Left: M51 Galaxy, 300s exposure
2017-Apr-13 19:54 UT, Clamecy, France

Right: Asteroid 2014 JO25, 30s exposure
2017-Apr-19 21:34 UT, Marseille, France

