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Amateur contributions to asteroid observations in the European Space Situational Awareness programme

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Abstract

As part of the ESA's Space Situational Awareness programme, regular asteroid observations have started at ESA's 1-m telescope on Tenerife. A significant contribution to the observations comes from amateur astronomers. This paper will present their contribution and summarize the current results of the observations.

1. Introduction

ESA's Space Situational Awareness (SSA) programme was started in 2009 and builds up systems to alert its users to events happening in space, in the three 'segments' Space Debris, Space Weather, and Near-Earth Objects [1]. The Near-Earth Object segment of SSA (SSA-NEO) specifically will have the task to provide a database with observations of NEOs, and provide warnings in case of close flybys or even hits of these objects. An important element is to contribute to follow-up observations of asteroids and their physical characterization. Also, a so-called 'wide survey' is currently studied which would complement the deep surveys currently ongoing.

To demonstrate and understand the capabilities of optical telescopes, ESA's Optical Ground Station, a 1-m telescope on Tenerife, is used regularly (approximately 2 nights every two weeks between full moon and new moon) for observing asteroids (IAU station code J04). Four different observation modes are used: (a) A survey mode, (b) Follow-up observations of objects on the 'NEO Confirmation Page' from the Minor Planet Center [2]; (c) Follow-up observations of objects on the 'priority list' of the Spaceguard central node [3]; (d) Photometric observations of individual asteroids, possibly in different filters.

For the final operational SSA system, European industry will provide tasking and data processing tools. As the programme is just starting, these tools are not yet available and for this test phase. The observations are thus performed with support of existing or newly developed software by one of us (M. Busch) working as an amateur astronomer. Also the final manual decision for newly discovered objects is supported by amateur astronomers.

2. Planning of the observations

For a real survey, the field of view of the telescope is comparatively small with about 0.7 x 0.7 deg^2. To demonstrate the survey, a scan over 5 x 5 images is performed.

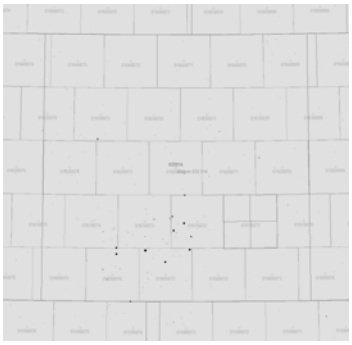

Figure 1: A screenshot of the planning software showing a scan area around the Plejades.

In each field, the 5 x 5 images are taken one after the other with an exposure time of 60 s. This is done three times, resulting in three images of the same area with a time interval of roughly 35 min between each other. In this time, the asteroids already move a detectable amount and a first 'tracklet' (i.e. a set of three position measurements) can be obtained. The scan area is revisited the next night to obtain a larger observing arc on the object's orbit.

The command files for the telescope are produced by special software which only needs an internal number for the search region as input which is linked to a position in the sky.

3. Data processing pipeline

After successful execution, the resulting image data are processed by a data processing pipeline based on the commercial astrometric engine PinPoint [4]. It takes the images obtained in the survey and identifies moving objects in the three consecutive images, automatically measures right ascension, declination, and magnitude of the identified objects, and matches the objects with known asteroids. All relevant data is immediately written to a web-based database.

4. Data analysis

For objects which were matched to a catalogued object, a report in the format needed for the official email notification to the Minor Planet Center is automatically generated. Objects which cannot be matched to any catalogue data could be either new objects or just noise. These are visually inspected to decide whether the object is real or just noise. To ease this task, the data processing pipeline automatically generates a web page showing still and animated sequences of a 70 x 70 pixel^2 window around the object. For registered users, the web interface shows three buttons with the option to mark the object as a new discovery, mark it as noise, or mark it as unknown.

After the pipeline has finished its work, a team of amateur astronomers (see list of co-authors) visually checks the data and makes the selections.

For objects which are confirmed as real, the software again generates the astrometric report which is then compiled by one of us (M. Busch) and sent by emailt to the Minor Planet Center.

5. Results

Most of the observing slots so far were hampered by bad weather. Still, a large number of observations were done in only a few nights. Together with the data from a preliminary campaign in Sep 2009, we have obtained the following statistics at the time of writing (end of May 2010):

- 114 asteroids were newly discovered
- 6356 position measurements of 1469 asteroids were submitted to the MPC
- The team made it on over 10 Minor Planet Circulars and 2 IAU Circulars (announcing newly discovered asteroids or comets) so far.

Conclusion

As part of ESA's Space Situational Awareness preparatory programme, observations of asteroids are performed at ESA's 1-m telescope on Tenerife. Before the existence of the final system which will have a tasking center and data processing centers, we successfully use the support of amateur astronomers in the evaluation of the data. This paper shows that the result is very encouraging and there is a lot of expertise and capabilities in the amateur community.

Acknowledgements

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References

[1] Koschny, D., Drolshagen, G., Bobrinsky, N., Gritsevich, N., The European Space Situational Awareness programme, EPSC2010-686, 2010.
[2] http://www.minorplanetcenter.org/iau/NEO/ToConfirm.html
[3] http://spaceguard.iasf-roma.inaf.it/SSystem/SSystem.html
[4] http://pinpoint.dc3.com/

Figure 2: Screenshot of the web page showing newly discovered objects. The image to the left of the sets of three is actually an animation.