EXTENSIONS OF THE FRAMEWORK FOR EVALUATION OF CRATER DETECTION ALGORITHMS BASED ON NEW ALGORITHM FOR REGISTRATION OF CRATERS AND GT-115225 CATALOGUE.

S. Lončarić1 and G. Salamunićcar2, 1 Faculty of Electrical Engineering and Computing, University of Zagreb, Unska 3, HR-10000 Zagreb, Croatia, sven.loncaric@fer.hr, 2 AVL-AST d.o.o., Av. Dubrovnik 10/II, HR-10020 Zagreb-Nov Zagreb, Croatia, gsc@ieee.org.

Summary: The framework for evaluation of crater detection algorithms (CDAs) was extended with: (1) a new algorithm for registration of craters; and (2) a new catalogue with 127172 craters which is the extension of previous GT-115225 catalogue.

Introduction: CDAs are an important subject of the recent scientific research, as it is evident from a tabular overview of 73 CDA publications by numerous authors as given in [1], as well as from 26 additional CDA publications as given in [2] and [3]. In our previous work, we proposed the open framework for objective evaluation of CDAs with first test-field subsystem based on 1/64° MOLA data [1]. Recently, we have extended this framework with 1/128° MOLA data, 1/256° THEMIS-DIR, 1/256° MDIM, and 1/256° MOC data-sets [4]. The main purpose was to support CDAs that utilize visual images, as e.g. [5] and [6]. Only the CDAs from [7], [8] and [9]-[3] (that utilize MOLA data) actually demonstrated the capability of processing data globally. In this work we present the additional extensions of the framework, in order to improve evaluation of such CDAs. In the future work the plan is also to integrate manually assembled catalogue with over 280000 craters [10] (once it is available).

Methods: The new extensions are as follows:

New algorithm for registration of craters. The previous algorithm for automated registration of craters works as follows: (1) crater-distance according to [1] is computed between each crater from CDA catalogue and each crater from GT catalogue; (2) when this distance is smaller than $cdf=0.5$, the correct match is confirmed and registration is performed. During our recent evaluation of the CDA which was used to produce T-75919 catalogue from [8] and our CDA [3], we noticed that both CDAs detected small craters much less precisely (particularly $D$ is overestimated) than large ones due to the limitations inherent to DEM. Consequently the previous algorithm for automated registration of craters cannot successfully match such craters with craters from a GT catalogue, and therefore labels them as false detections. It is not a solution just to increase $cdf$, because crater-distance between two different craters can be only slightly larger than 0.5, as shown in [2]. Therefore we developed a new algorithm which in addition: (1) takes into account that large craters are in average much closer to each other (there are more intersections between craters) than the small craters (they are usually at larger relative distance from each other); and (2) evaluates registration context (nearby craters) and performs more flexibly the matching outside of craters-clusters and more rigorously the matching inside of clusters.

Extensions of previous GT-115225 catalogue. Only the CDAs from [8] and [3] resulted in a global crater catalogue. Therefore in the first step, we merged GT-115225 catalogue which was the result of CDA from [3] with the T-75919 catalogue which was the result of CDA from [8]. In order to show the completeness of the resulting catalogue, for additional registrations in GT, Shen-Castan based CDA from [3] was used as the most different from the Canny based CDA from [3].

Results: The results of the new algorithm for registration of craters are given in Fig. 1 for catalogues GT-57633 [2] and GT-115225 [3]. The results of work on the new GT catalogue are given in Fig. 2.

Conclusion: As the results show, the new algorithm is necessary, in addition to much more complete GT catalogue, so that considerably better evaluation of such CDAs can be done. The GT-115225 catalogue [3] was significantly extended using T-75919 catalogue [8], while the subsequent Shen-Castan based extension was considerably smaller, as it was expected.

Acknowledgements: To T. F. Stepinski for providing the catalogue with 75919 craters; colleagues D. Gržanić, M. Karas, D. Katušić, S. Katušić, J. Lucić, D. Mehnić, V. Primorac, B. Spasić, and Lj. Šare for providing computers for the cluster which was used for faster computation of optimal parameters for CDA.

This F-ROC is based on old GT-57633 catalogue and old algorithm for registration of craters for \( cdf < 0.5 \). This F-ROC is based on new GT-115225 catalogue and new algorithm for registration of craters for \( cdf < 3 \).

**Figure 1:** Comparison of F-ROC evaluations for 2 Canny based CDAs optimized for large and small craters: (1) using old GT-57633 and new GT-115225 catalogue; and (2) using old and new algorithm for registration of craters.

**Figure 2:** Schematic flow diagram of the work on the new GT catalogue based on previous GT-115225 catalogue.