CRATER DETECTION FROM VENUS DIGITAL TOPOGRAPHY AND COMPARISON WITH MARTIAN AND LUNAR CRATERS. G. Salamunićcar[1,2] and S. Lončarić[2], [1]AVL-AST d.o.o., Av. Dubrovnik 10/II, HR-10020 Zagreb-Novi Zagreb, Croatia, gsc@ieee.org, [2]Faculty of Electrical Engineering and Computing, University of Zagreb, Unska 3, HR-10000 Zagreb, Croatia, sven.loncaric@fer.hr.

Summary: We used a crater detection algorithm (CDA) for detection of craters from Venus digital topography and computation of the depth/diameter ratio. The results were compared with the accompanying results for Martian and Lunar craters.

Introduction: The main motivation for the intensive research on CDAs by several international teams is the volume of acquired data which increases significantly with each new lunar and planetary mission. Recent work has already resulted in some of the most complete catalogues of Mars [1, 2, 3, 4, 5], the Moon [5, 6, 7] and Phobos [8, 9]. However, only one CDA has been used so far for the extraction of craters from Venus imagery [10], wherein this CDA used optical images. The advantage of CDAs that utilize digital elevation map (DEM) images is the straight-forward possibility to measure craters' morphological characteristics, which was the main motivation for this work.

Datasets and Methods: Datasets used and methods developed are as follows:

Venus topography. The Magellan Global Topography Data Record (GTDR) archive contains topographic data acquired by the Magellan spacecraft during its mission to Venus [11]. We used the highest available resolution of 1/22.767°, upsampled to 1/32°.

Crater detection algorithm. In our previous work, we developed a DEM-based CDA [3] and improved it using a specially developed interpolation method [5]. This makes the CDA suitable for detection of craters only a few pixels in diameter. This is important because Venus topography is so far available solely in low resolution (1/32° = ~3.3 km per pixel).

Manual verification of detections. Each crater is verified as a correct detection using the previous manually assembled catalogue with 967 craters [12] and automated matching of craters between different catalogues [1, 4]. Using such an approach, each crater from the resulting catalogue has double confirmation that is indeed a crater: one is the entry in the used catalogue; another is detection via our CDA.

Results: The preliminary results are as follows:

Crater detections. As shown in Fig. 1, our CDA can successfully detect craters from the Venus DEM. The diameter of the largest detected crater is 270 km (Mead crater), while the diameter of the smallest detected crater is 7.6 km (Oma crater). Horizontal resolution of the available topographic image is insufficient for detection of smaller craters.

Assembled catalogue. The resulting VE345GT catalogue contains 345 craters successfully detected by our CDA. The benefit over the previous manually assembled catalogue is that we used our CDA to measure depth/diameter ratios of all craters included in our resulting catalogue.

Assessment of the catalogue's completeness. According to an assessment of completeness estimated using the *Craterstats* [13] program, as shown in Fig. 2, VE345GT is mostly complete for ~ $D \geq 30$ km. It was not possible to detect considerably smaller craters because of the limited resolution of the DEM used.

Depth/diameter relationship. Differences between Martian and Lunar craters regarding depth/diameter relationship are known from previous work [5]. As shown in Fig. 3, in this work we added craters from the VE345GT catalogue to the diagram. Diameters are known from the catalogue, while depths are computed using the CDA and the Venus DEM.

Conclusion: Despite low resolution and considerably higher noise than in the case of Martian and Lunar DEMs, our CDA successfully detected a considerable number of craters from the Venus DEM. As shown, Venus craters on average have a slightly smaller depth/diameter ratio than Martian and Lunar craters. In future work, our plan is to extend the catalogue with smaller craters, by additionally using optical images that are already available in much higher resolution.

References: [1] Salamunićcar G. and Lončarić S. (2008) *Adv. Space Res.*, *42*, 6-19. [2] Salamunićcar G. and Lončarić S. (2008) *Planet. and Space Sci.*, *56*, 1992-2008. [3] Salamunićcar G. and Lončarić S. (2010) *Trans. Geosci. Remote Sens.*, *48*, 2317-2329. [4] Salamunićcar G. et al. (2011) *Planet. and Space Sci.*, *59*, 111-131. [5] Salamunićcar G. et al. (accepted) *Planet. and Space Sci.*, 1-12, doi:10.1016/j.pss.2011.09.003. [6] Lončarić S. et al. (2011) *LPS XLII*, Abstract #1454. [7] Salamunićcar G. et al. (2011) *ISPA*, 597-602. [8] Salamunićcar G. et al. (2011) *LPS XLII*, Abstract #1451. [9] Salamunićcar G. et al. (2011) *ISPA*, 591-596. [10] Barata M. T. et al. (2010) *LPS XLI*, Abstract #1412. [11] Ford P. G. (1992), *NASA Planetary Data System*, <http://pds-geosciences.wustl.edu/geo/mgn-v-gxdr-v1/mg_3002/gtdr/sinus/>. [12] USGS (1999), "http://astrogeology.usgs.gov/Projects/VenusImpactCraters/venuscraters.xls". [13] Michael G. G. (2010) *Craterstats application*, <http://hrscview.fu-berlin.de/craterstats.html>.

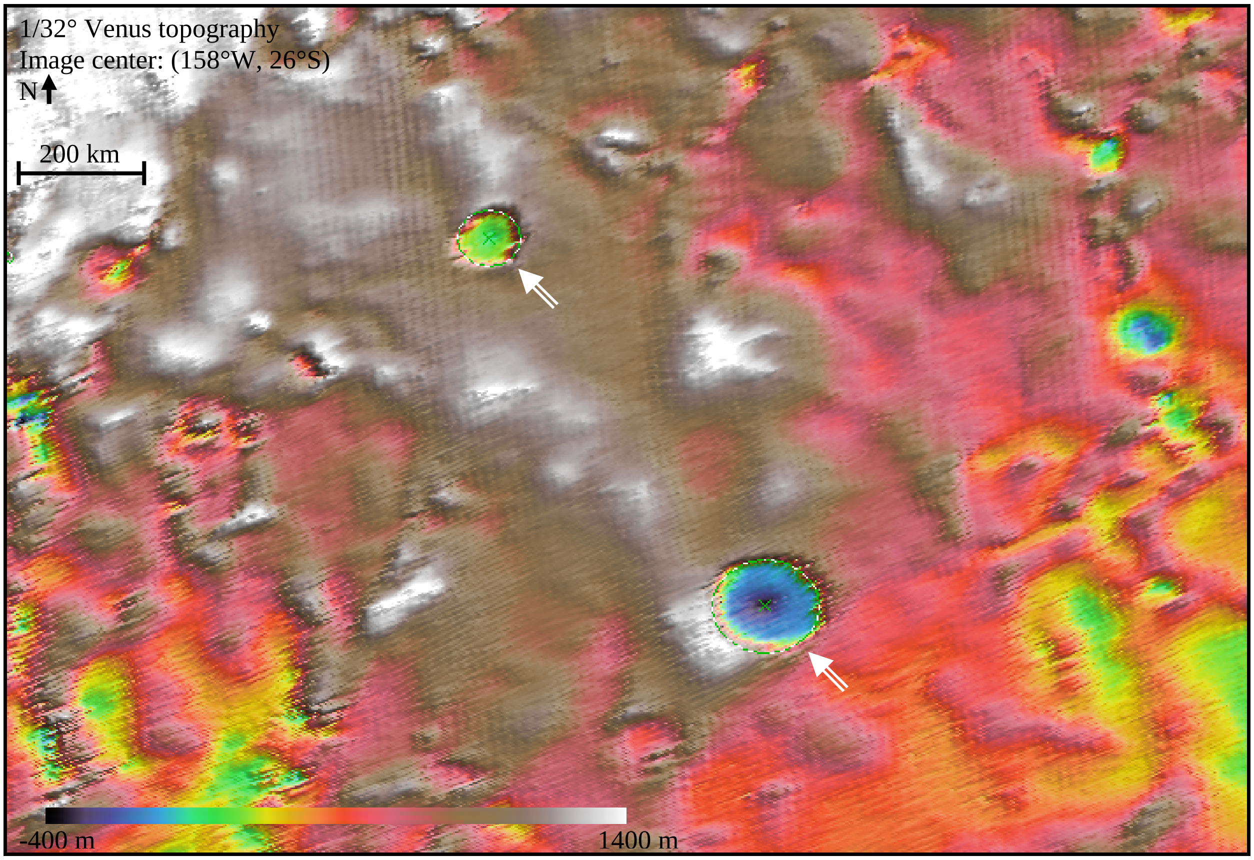

Figure 1: Detection of craters from Venus topography using the Crater Shape-based interpolation CDA, Stanton crater (top-left) and Isabella crater (bottom-right).

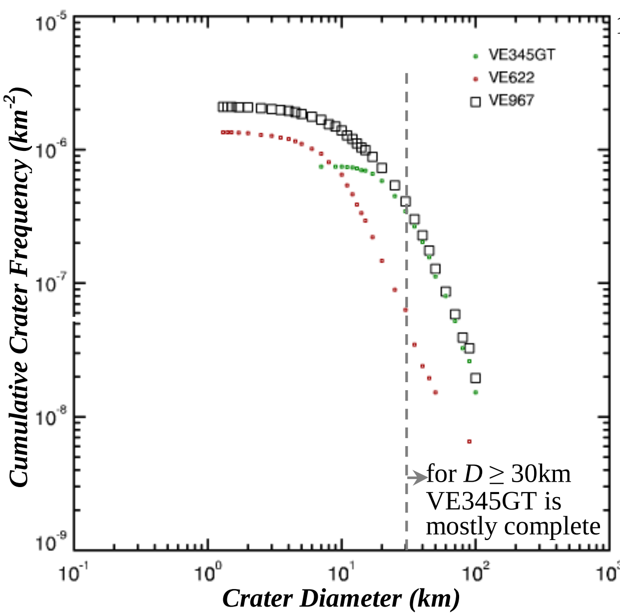

Figure 2: Assessment of completeness of VE345GT catalogue. The graph shows completeness of the catalogue for craters larger from 30 km in diameter.

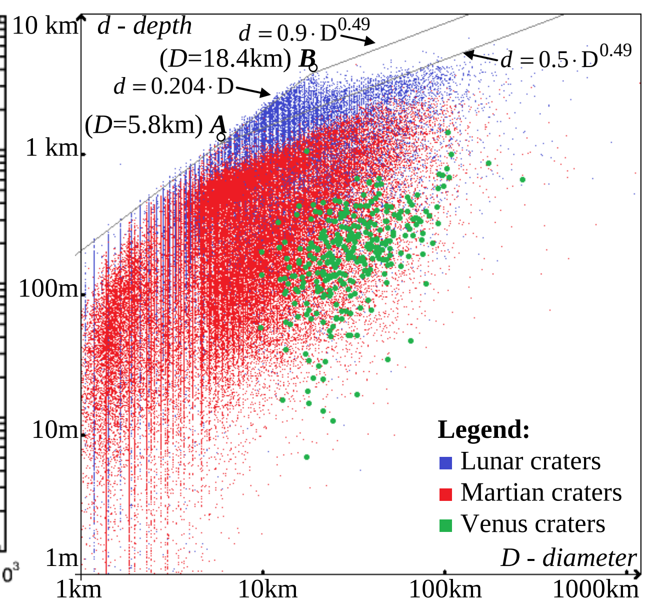

Figure 3: Depth/diameter in log/log scale for all craters from the following catalogues: (1) Lunar LU60645GT; (2) Martian MA132843GT; and (3) Venus VE345GT.