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Relating polygonal crater morphology, tectonic setting and shallow crustal structure on Mars: a machine vision approach

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We use a new, highly automated image-processing computation for mapping properties of the Martian surface and shallow crust indicated by the morphology of polygonal impact craters ranging in size from small secondaries (where planes-of-weakness control excavation) to large complex craters (where planes-of-weakness control crater collapse). Going forward, as new and abundant high-resolution imagery is acquired from the heavily cratered surfaces of Mars, the Moon and Mercury, there is increasing need for machine vision technologies that can automatically characterize the shapes of impact craters, in order to estimate the relative age and structure of crustal materials and to identify the extent and style of crater modification. Among other measures, our software obtains the azimuth and length distributions of straight wall segments (in rim and floor outlines) of diverse polygonal crater populations. Based on these results, we find relations between fracture networks in target materials and the segment distributions obtained from small crater outlines. In the case of complex craters, these data are used to generate tectonic reconstructions indicating the regional stress directions that may have prevailed early in Martian history when very large craters formed. Our approach may be adapted to automatically assess crater preservation state in an objective fashion, as well as identify concentric and flat-bottomed simple craters (which can be used to estimate regolith thickness), rare populations of small circular craters (indicating weakly indurated target materials), and Quasi Circular Depressions (QCDs) in the northern plains (in MOLA topography).