SMALL SCALE SURFACE ROUGHNESS OF RYUGU. Katharina A. Otto[1], Rutu Parekh[1,2], Klaus-Dieter Matz[1], Ralf Jaumann[1,2], Katrin Krohn[1], Katrin Stephan[1], Nicole Schmitz[1], Tra-Mi Ho[3], Stephan Elgner[1], Maximilian Hamm[1], Rie Honda[4], Shingo Kameda[5], Frank Preusker[1], Frank Scholten[1], Stefan Schröder[1], Hiroki Senshu[6], Seiji Sugita[7] and Frank Trauthan[1]

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Introduction: JAXA's Hayabusa2 mission arrived at C-type near Earth asteroid Ryugu in June 2018 and the on-board Mobile Asteroid Surface Scout (MASCOT) was dropped by Hayabusa2 on October 3rd, 2018 [1, 2]. MASCOT is equipped with four scientific instruments including a camera (MasCam), a radiometer (MARA), a hyperspectral microscope (MicrOmega) and a magnetometer (MasMag) aiming at investigating the surface's structure, mineralogical composition, thermal behaviour and magnetic properties [3]. After successfully settling on the surface and activating an internal mobility unit, MASCOT achieved the desired orientation for in-situ observations on the surface where it operated for 17 hours and 17 minutes during day and night time. MasCam [2] imaged the surface during day time at ambient illumination conditions and during night time using four colored LED arrays (red, green, blue, infrared).

Observation: During its operation on Ryugu's surface, MasCam imaged the surface at multiple occasions during day and night time [2]. MasCam uses the Scheimpflug principle and thus the pixel resolution varies starting at ~0.2 mm in the front of the image [4]. During night time the LEDs illuminated the surface from slightly below the camera lens. A vertical offset of the LED array introduces a shadow cast to the top right in the images (Figure 1). These shadows emphasize rough surface structures.

Method: Using LED illuminated night time images of Ryugu we defined surface structures at pixel resolutions of ~0.2 mm using image analysis techniques. We identified areas of similar texture and brightness using a growing region algorithm starting from a representative area of interest (Figure 1). The outline of these areas and their reference surfaces acquired by smoothing the rough outline were subsequently used to derive several commonly used roughness parameters including the fractal dimension, RMS slope, small scale roughness parameter and hemispherical crater density typically used in thermal modelling to approximating sub-resolution roughness.

Outlook: We derived a number of roughness parameters from images of Ryugu's surface necessary for the correct interpretation of a number of remote sensing and in situ data including thermal emission and reflectance spectra. We also applied our method to images of comet 67P and find that both bodies have similar degrees of roughness.

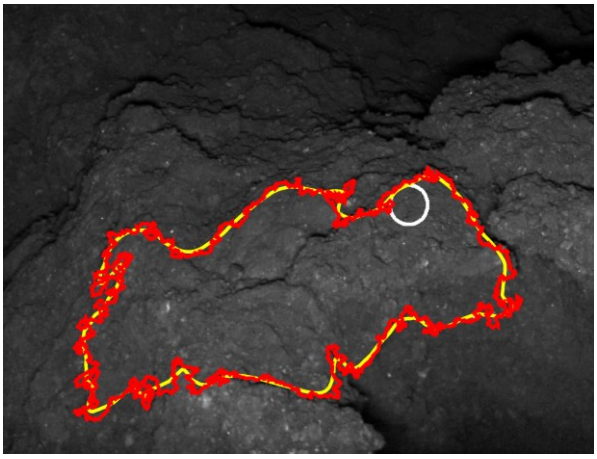

Figure 1: Outline (red), smoothed outline (yellow) and representative texture (white circle) of surface structure on Ryugu from which roughness parameters were derived.

References:

[1] Watanabe, S., Hirabayashi, M., Hirata, N., Hirata, N., Noguchi, R., et al.: Hayabusa2 arrives at the carbonaceous asteroid 162173 Ryugu - A spinning top-shaped rubble pile. Science eaav8032, 2019. [2] Jaumann, R., Schmitz, N., Ho, T.-M., Schröder, S.E., Otto, K.A. et al.: Images from the surface of asteroid Ryugu show rocks similar to carbonaceous chondrite meteorites. Science 365, 817–820, 2019. [3] Ho, T.-M., Baturkin, V., Grimm, C., Grundmann, J.T., Hobbie, C., et al.: MASCOT - The Mobile Asteroid Surface Scout Onboard the Hayabusa2 Mission. Space Science Review 208, 339–374, 2017. [4] Jaumann, R., Schmitz, N., Koncz, A., Michaelis, H., Schroeder, S.E., et al.: The Camera of the MASCOT Asteroid Lander on Board Hayabusa 2. Space Science Review 208, 375–400, 2017.