Comparative Analysis of Feature Matching Algorithms for Extreme Region Exploration

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Abstract: Recently, many countries have begun to take an interest in exploring extreme regions such as tundra and desert areas. Exploration of such regions has found valuable resources and has tremendous geological values. Due to the characteristics of such wild regions, it is not easy to access the terrains without the assistance of special cars, drones, or rovers. In this regards, this research is focusing on the 3D modeling of wild terrains using the image data acquired from an exploring rover. As the stage of designing a rover, a small mobile platform (with 0.4m x 0.6m of dimension) is selected. On the platform, two mast cameras (i.e., night vision stereo cameras which can rotate 360 degrees), two front hazard cameras, two rear hazard cameras, left- and right-side fisheye lens cameras, and GPS-INS system are installed. Among the datasets acquired from different camera types, this research is focusing on that from night vision cameras. We used rocks, soils, and gravels to prepare the test area having similar characteristics of wild terrains (especially, like tundra). The rover can navigate using the images acquired from the optical sensors. To accomplish this work, the real-time geo-referencing is an essential process to determine the rover's positions and directions. At this stage, the accurate image matching is required to successfully perform this task. Image matching step usually follows the process of feature detection, feature matching, and aligning two or more images acquired at different positions. Hence, this research compared the performances of several image matching algorithms using the night vision images. One should note that we are dealing with test area like wild terrain; hence, there are no strong artificial features. In this research, the performances of four different feature matching algorithms (i.e., SIFT, SURF, ORB and AKAZE) were compared together. SIFT showed the best performance among four algorithms; however, relatively low computational efficiency. Also, ORB showed the highest computational efficiency; however, it showed the lowest accuracy. As future work, the 3D modeling of wild terrain will be produced using the outcomes from the automated feature matching.

Keywords: Feature matching, Mobile platform, Rover, Extreme region, Tundra