Verification and Possibility on the Operation of Gravel Bed River Measurement using UAV and SfM-MVS

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Recently, it is possible to acquire high spatial resolution information by UAV (Unmanned Aerial Vehicle) and SfM-MVS (Structure from Motion –Multi-view Stereo). Terrain surveying by UAV and SfM - MVS has the advantage that it is possible to acquire terrain information of high spatial resolution at low cost. Further, there is an advantage that the survey designer can freely measure at the timing at which data is desired to be acquired. As a result, it became possible to acquire topographical information with higher temporal resolution than conventional aerial photographs.
Utilizing the merit of acquiring terrain information of high spatiotemporal resolution, We have the ultimate purpose of monitoring the topographic change of the gravel bed river. First, the resolution of DSM (Digital Surface Model) that can be generated by UAV and SfM - MVS is about 10^0 ~10^1cm, and can grasp riverbed gravels one by one. Also, the gravel bed river in Japan has a steep gradient and a large flow rate, so the flow velocity is fast. However, in the existing research, there are many researches that analyzed the target site based on data once captured with high spatial resolution. In this research, through verification experiments and on-site survey experiments, verification is performed on the surveying of the gravel bed river, proposing the analysis process, and giving issues to calculate the topographic variation.
First, we measured the bricks size assuming riverbed gravel using UAV and SfM - MVS and verified how accurate the actual bricks size are.
It is the GCP (Ground Control Point) that is given at analysis time to give the most influence on the accuracy of the DSM. GCP should be placed on the xy plane of the object to be surveyed from the end to the end, the highest point and the lowest point in the z direction, and interpolate the object.
We actually tried to measure the gravel bed river. The target area is the Tedori River, Ishikawa Pref., Japan, which is a first-class river with a source in Mt.Hakusan. We shot riverbed using UAV at a frequency of about once every two weeks. At that time, it flew at the altitude of 30m according to the aerial law. The GCP set the reference point using temporary survey data (here, taken for 8th December 2016) and used it for data of other periods and used it. The resolution of the DSM was 2.5cm.
As a result, we were able to capture the actual gravel (Fig.1). The size of the gravel that could be caught was about 50cm. In addition, we could express the shape of gravel by drawing contour lines. We tried to measure the transportation / deposition situation of gravel by extracting this difference from DSM at other time. As a result, a horizontal error of about 45cm occurred, and it was impossible to extract the difference by gravel size. The horizontal accuracy of GCP is about 5cm, whereas the systematic nature which was not noticeable also in error of DSM was not seen. Therefore, rather than using GCP using relative coordinates, it is possible to use precision surveying such as GNSS (Global Navigation Satellite System) and RTK (Real Time Kinematic).
In continuing this research it is possible to connect the development process of the gravel growing with the conventional geomorphological research results for the first time by solving this problem. By capturing the change of micro topography with DEM, it is possible to simulate the terrain development process of hundreds of thousands of years scale, realize the terrain development simulation. In the Tedori River, the outflow of gravel has been actively carried out since the construction of the dam, and the bed change is intense even for decades. In the future, we would like to estimate the topography development on the scale of hundreds of thousands of years, and think about deepening the consideration of river channel

change and environmental change.

Keywords: Topographic measurement, High-definition Topographic Data, Grabel bed river, Digital Surface Model(DSM)

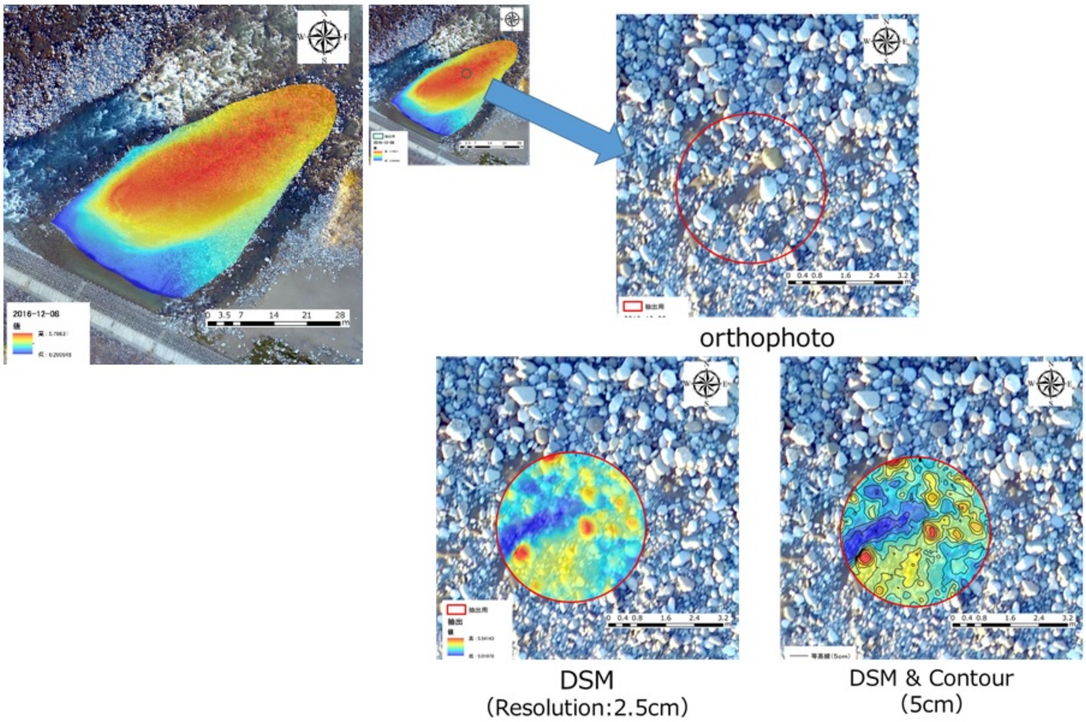

Fig.1 DSM and Orthophoto of the gravel bed river generated by UAV and SfM-MVS

