A UAV-based approach to estimate the uncertainty in GNSS locations over a broad-spatial scale

*Shun Nagasaku[1], Hiroto Shimazaki[1]

1. National Institute of Technology, Kisarazu College

Location data obtained by GNSS-based telemetry has been widely used for estimating the movement patterns, home range size, and resource selection of free-ranging animals. Although the GNSS-based telemetry has advantages over conventional VHF radio telemetry in terms of positional accuracy and precision, it is still important to define the confidence interval of the estimation by accounting for the uncertainty in location data. Since the uncertainty in GNSS locations is mainly induced from GNSS signal interruption by rugged terrain and off-terrain objects such as buildings and tree canopies, Canopy Openness (CO) has been commonly used as the first-order approximation of the GNSS signal interruption probability (GNSS-SIP). However, applicability of the CO is limited in specific locations where hemispherical images were taken for estimating CO. To evaluate the uncertainty in GNSS locations for free-ranging animals, an alternative method must be employed.

This study examined the potential of a UAV-based approach to estimate the degree of uncertainty in GNSS locations over a broad-spatial scale. A set of high-spatial-resolution aerial images acquired from the UAV platform was used to derive a Digital Surface Model (DSM) and a quasi-DSM. The DSM represents bare ground surface and includes all objects on it, while quasi-DSM is identical to the DSM except for tree canopies. Morphometric Protection Index (MPI) was derived from the DSM. Elevation Mask (EM) was then derived from the DSM and quasi-DSM to be used in GSILIB software for predicting the values of Geometrical Dilution of Precision (GDOP) and number of satellites (NSAT).

The degree of conformity of the MPI to CO was confirmed by a simple linear regression model, and the CO was successfully estimated from MPI over a broad spatial range. However, because the MPI was calculated based on the DSM, the following problems remained unsolved: (1) the CO predicted from MPI represents only the CO at top of the terrain or off-terrain objects; and (2) it cannot consider the effect of GNSS signal transmission through an object or gaps among objects. In contrast, the GDOP and NSAT, which were derived from the DSM and quasi-DSM via the EM, were found to be capable of more properly estimating the positioning accuracy and precision. This might be attributed to the fact that the GDOP and NSAT were predicted taking into account the GNSS satellites constellation and the effect of GNSS signal transmission through an tree canopy and gaps among canopies. In conclusion, the UAV-based approach would be a promising method to estimate the degree of uncertainty in GNSS locations over a broad-spatial scale.

Keywords: GDOP, NSAT, Elevation Mask, Canopy Openness, Morphometric Protection Index