Relative Pose Calibration Between Optical and Range Sensors

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Abstract: Various remote sensing sensors, such as optical, thermal, laser, radar, etc., have been developed to acquire useful information from the targets without directly contacting them. Such sensors have their own characteristics. For example, optical sensors provide the brightness values reflected from the object using the visible range of the light. However, they do not directly provide three-dimensional information. On the other hand, range sensors can provide three-dimensional information; however, no information from the visible light. From this fact, we can figure out that the weakness of one sensor can be compensated for by the other sensor. In this regards, this research aims to integrate different sensor, especially optical and range sensors, and to produce richer information through the sensor integration. As a critical step of the sensor integration, the system calibration between the optical and range sensors has to be first carried out. Simulated and real data are prepared for this research. The test-bed with 5m of width and 4m of height is prepared to deal with both of the optical and range sensors. Also, lens distortions, measurement errors, and range errors are considered in the experiments. Two scenarios: 1) two-step procedure based on the single photo resection; and 2) one-step procedure based on the bundle block adjustment, are considered. In the two-step procedure, single photo resection is first carried out for the optical and the range sensors, separately. Afterwards, the relative pose computation between two sensors is accomplished. On the other hand, the one-step procedure considers the six parameters of the relative pose between two sensors as unknown parameters in the bundle block adjustment procedure. In other words, the exterior orientation parameters of the range sensor are derived from the combination of the exterior orientation parameters of the optical sensor and the relative orientation parameters between two sensors. In terms of the efficiency, one-step procedure is better than two-step procedure since the two-step procedure has to deal with all the separate computation at all the positions. Moreover, the one-step procedure provides more reliable angle computation compared to the two-step procedure. More specifically, the computed phi parameter of the relative orientation derived from the two-step procedure is three times worse than that from the one-step procedure. It is also found that the range measurements provided from the range sensor make the significant contributions to the computation of the phi-angle. Conclusively, this research designed two different scenarios of the system calibration and compared the results acquired from the scenarios. In terms of the computational efficiency and the reliability of the derived angles, the one-step procedure can be recommended for the system calibration. As future work, the data integration and indoor mapping will be carried out based on the system calibration results.

Keyword : Optical sensor, Range sensor, Sensor integration, System calibration