Table 3. Comparison of accuracies of 3D coordinates of feature points

| | $X$ | | $Y$ | | $Z$ | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | $\sigma_X$ | $\bar{Y}$ | $\sigma_Y$ | $\bar{Z}$ | $\sigma_Z$ |
| all images | 36.648 | 1.584 | -37.019 | 1.239 | 51.935 | 1.945 |
| selected images | 35.793 | 1.226 | -35.849 | 1.324 | 50.856 | 1.803 |

$\bar{X}$ , $\bar{Y}$ , $\bar{Z}$ : 3D coordinates on average of feature points

$\sigma_X$ , $\sigma_Y$ , $\sigma_Z$ : standard deviations of measurement errors of the corresponding 3D coordinates

Table 4. Comparison of accuracies of exterior orientation elements (translations)

| | $X$ | | $Y$ | | $Z$ | |
|---|---|---|---|---|---|---|
| | $\bar{T}_X$ | $\sigma_{T_X}$ | $\bar{T}_Y$ | $\sigma_{T_Y}$ | $\bar{T}_Z$ | $\sigma_{T_Z}$ |
| all images | 146.054 | 6.014 | -137.498 | 6.515 | 214.513 | 9.021 |
| selected images | 146.054 | 6.268 | -137.498 | 6.79 | 214.513 | 9.402 |

$\bar{T}_X$ , $\bar{T}_Y$ , $\bar{T}_Z$ : translation on average of frames

$\sigma_{T_X}$ , $\sigma_{T_Y}$ , $\sigma_{T_Z}$ : standard deviations of measurement errors of the corresponding translations

In the tables 3, $\bar{X}$ , $\bar{Y}$ , $\bar{Z}$ express 3D coordinates on average of feature points, and $\sigma_X$ , $\sigma_Y$ , $\sigma_Z$ standard deviations of measurement errors of the corresponding 3D coordinates, respectively. Also in the table 4, $\bar{T}_X$ , $\bar{T}_Y$ , $\bar{T}_Z$ express translation on average of frames, and $\sigma_{T_X}$ , $\sigma_{T_Y}$ , $\sigma_{T_Z}$ standard deviations of measurement errors of the corresponding translations, respectively.

The proposed method kept accuracies as almost same as ones with original with all images. Through the experiments, the significance of the proposed method was also confirmed. Accordingly, Potential to efficient and accurate 3D measurement was implied.

## 5. CONCLUSIONS

This paper develops an automatic image selection method considering network design for huge amount of images. The proposed method is based on image connectivity graph. The image connectivity graph consists of nodes as images and cost edges as FOD consideration. The image selection is corresponding to reduction of the edges. Graph cuts as combinatorial optimization method is applied for the edge reduction. Through experiments with real data, the proposed method achieves 75% of the number of edges. At the same instance, the accuracy can be kept as one of before applying image selection. Accordingly, efficiency improvement with keeping accuracy is confirmed.

As a future work, application of the method to not only sequential images but also various kinds of images such as shared images on the internet. In such cases, interior orientation elements should be introduced. To deal with the additional elements, definition of cost function for the edges will be investigated. In current situation, only estimation accuracy of translation between two images is set as cost function. By introducing estimation accuracies of rotation of camera, 3D coordinates of feature points, and interior orientation elements, it will be expected to represent relationships between images deeply. Furthermore, discussion about relationships between efficiency and accuracy will be required. As a result, applicability of photogrammetry will be more increased.

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