# HIGH-ACCURACY OF ORTHORECTIFICATION MODEL WITH SELF-GEOMETRIC CONSTRAINT FOR HIGH BUILDINGS IN URBAN AREA

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## ABSTRACT

Digital orthophotos are a critical component of the National Spatial Data Infrastructure-NSDI. In recent years, so-called true orthophoto generation has been interested to many researchers. Briefly, the true orthoimage generation is composed of Digital Terrain Model (DTM)-based orthoimage generation, DBM (digital building model)-based orthoimage generation, and their merging. Some associated work for true orthoimage creation is the occlusion detection and refilling, shadow detection and compensation, and radiometric difference balance. However, in urban area, especially in very high building urban area, the early true orthophoto generation method is still not capable of orthorectifying the displacements caused by high buildings, i.e., their walls can be viewed in the orthoimage. When we created true orthoimage for those high buildings, such as over 150m high, we found that some of high buildings cannot be completely orthorectified into their upright and correct position. The incomplete orthorectification is probably directly caused by the inexact exterior orientation parameters(EOPs) because the traditional orthorectification algorithm largely depends on both accuracy and distribution of ground control points (GCPs). Moreover, these GCPs are usually laid out in the ground. However, buildings occluding buildings and/or buildings occluding ground frequently happen in urban areas, resulting in that the well distribution of GCPs is impractical. Thus, the orthorectified images might be incomplete.

This paper first presents how to exam which type of errors causes this incomplete orthorectification in urban high-building area, and then presents a new method for

orthorectification of high buildings in urban area. The proposed method in this paper is different from the traditional methods, which improved the accuracy by increasing the number and/or improved the geometric distribution of ground control points. In building models, there exists plenty of geometric information in the façade of building, such as perpendicularity, parallelism among straight lines and planes. All of these relationships can be regarded as the constraint conditions of unknown parameters (i.e. relative control conditions). To improve the accuracy of orthorectification, the relative and absolute control information appeared in the reference object should be considered. These control information includes the distance (between the central point of camera and 3D space point); the point located in a plane; the point located in a straight line; the known angle and other known graphs. This proposed method first established mathematical model of constrain condition on the building edges, such as perpendicularity, and then the established constrain conditions are merged into the orthorectification model. In this paper, the model of describing each building is realized by using a parameterized constructive solid geometry (CSG) method. In this model, each element of CSG primitive has been assigned with its properties, and each building model has already contained its geometric topology. Thus, the characteristics of topology can automatically be transferred into the relative controls. A test field located in downtown of Denver, Colorado has been used to evaluate our methods. The experiments of comparing the accuracy achieved by our method and other methods are conducted, and two methods are employed to compare the accuracy of different orthorectified methods: one is visual measurement check, another is checkpoint check. The experimental results demonstrated that the proposed method can improve the accuracy of 2-5 feet for those buildings of over 100 m high, and even 5-7 feet for those buildings over 100 m high in the margin of imagery.

**Keyword:** True orthophoto; Digital building model; Self-geometric constraint; Orthorectification model;