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AN OPEN STANDARD-BASED SENSOR WEB APPROACH FOR ONLINE 3D EXTRACTION: USING SENSOR OBSERVATION SERVICE, SENSORML AND RATIONAL FUNCTION MODEL

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Motivation

Today, while the computing trend is toward open, web -based and distributed systems, photogrammetry systems still remain desktop or workstation based systems. There are few existing efforts in web photogrammetry, such as ARPEMTEUR system (http://www.arpenteur.net/) . However, the architecture is still using a closed and central design. Closed means the system uses proprietary information encodings and protocols, and cannot interoperate with other systems. Central means it uses a client -server architecture, which is not scalable. The other problem is the interoperability of photogrammetry. Historically, photogrammetry has a strong proprietary nature. The proprietary nature limits the use of photogrammetry within a narrowly defined conventional mapping community . Because of the limited number of users and small market size, photogrammetry systems are expensive tools. Recent developments in sensor -independent models such as rational polynomials and World Wide Web -based data distribution and processing services expedite the interoperability of photogrammetry. In this paper, we introduce an open standard -based Sensor Web approach for online 3D extraction . The proposed design and architecture is open, distributed and interoperable comparing to existing web photogrammetry systems.

Methodology

A Sensor Web is a group of distributed and heterogeneous sensors that interconnected by a communication fabric and sharing information through interoperable interfaces. In this research, firstly, we analyze and decompose photogrammetry work flow from a Sensor Web point of view. The purpose is to identify the components of a photogrammetry work flow that can be described and implemented using open Sensor Web standards. We choose a Rational Function Model (RFM) based method using single high - resolution satellite image and DEM to extract building height as our reference photogrammetry work flow. The RFM method will be introduced in the full paper.

Then, we identify that there are two major information (data) components needs to be described in stardard way in our RFM-based method. First is the imagery for measurement. Second is the sensor and sensor model. From a Sensor Web perspective, an imagery is an observation that measured by a sensor at certain position at certain time. Thus, we use O&M schema, an OGC (Open Geospatial Consortium) information model for observations, to design an information encodings to describe imagery and its relationship with associated entities. Examples are the time imagery was taken, sensor used, sensor model, etc. Details of how to apply O&M model to a photogrammetry imagery will be explained in full paper. Examples of using O&M to present an IKONOS image will also be presented in the full paper. Then we use SensorML, an OGC information model for sensors, to design an information encodings to describe sensor and its relationship with associated entities. For example, we use SensorML to describe rational polynomials as a sensor independent model in this research.

Secondly, we use Sensor Observation Service (SOS) as the web service interface to serve the data required in our RFM model based online 3D extraction. SOS is a web service to fetch observations from a sensor. It is the intermediary between a web client and an observation repository. In this research, the observation repository is an imagery database. Web client can also obtain information that describes the associated sensors through SOS interfaces. This is especially important for our online 3D extraction, because in order to perform the task, we need both the imagery and the associated sensor information including sensor model.

Thirdly, in our RFM approach of 3D measurement from single image, we need to utilize DEM to obtain terrain height information for calculating building heights. Therefore, we add an OGC Web Coverage Service (WCS) into the architecture for serve DEM needed in the photogrammetry work flow. By definition, a WCS provides access to potentially detailed and rich sets of geospatial information, in forms that are useful for client-side rendering and input into models. It is widely used to serve DEMs on the web.

The last component of our architecture is the web client. It is a web-based software to perform the photogrammetry task, including image processing, human -computer interaction, and 3D information extraction . It requests the required data through open standard Sensor Web interfaces. These data includes imagery from SOS, SensorML (including RPC) from SOS, and DEM from WCS. An architectural design and diagrams will be presented in the full paper.

In the full paper, we will also present a prototype system that is composed of the components introduced above to demonstrate the proposed open standard-based Sensor Web approach for online 3D extraction . An IKONOS image and its associated sensor metadata will be used as an example to exercise the photogrammetry work flow for single image 3D information extration.

Conclusion

We presented a new architecture for interoperable web photogrammetry using Sensor Web standards in this paper. The major contribution of this paper is the interoperability of photogrammetry. All information required in the photogrammetry work flow is encoded in open standard -based Sensor Web information model and encodings. Imagery, sensor metadata, sensor model, and DEM are located in distributed servers and transmitted through open standard -based web service interfaces. This architecture is following the current computing trend that is open , salable, and distributed. We believe an interoperable photogrammetry system will contribute to a broader user base, bigger photogrammetry market, and less-expensive photogrammetry tools .