International Cartographic Association
Association Cartographique Internationale

Quality Assessment of the OpenStreetMap Road Network in Calgary, Alberta

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Keywords: OpenStreetMap, road network, mapping, geospatial data, position, accuracy, VGI platforms

Abstract:

Voluntary geographic information (VGI) platforms have rapidly grown in recent years due to the advancement of technologies, providing more and more accurate and up-to-date versions of geo-referenced data over large areas (Goodchild, 2007). Despite large quantities of geospatial data and many applications produced by VGI projects, users are often unaware of their quality. Among the various VGI projects on the Internet, OpenStreetMap (OSM) has achieved the highest popularity (Yan et al., 2020). OSM is a platform where people can voluntarily create or edit maps of various types, such as streets and roads, from all around the world. These maps are created by uploading GPS tracks or by tracing and converting features from high-resolution satellite images into digital form (Haklay and Weber, 2008). In the OSM database, road networks are one of the most frequently occurring spatial contents. However, these representations' quality can vary from location to location (Brovelli et al., 2017). In recent years, geospatial data quality in OSM has become an important research topic as a result of the large size of the dataset and multiple access channels (Flanagin and Metzger, 2008). Thus, the primary objective of this project is to examine the overall reliability of the OSM road network in Calgary.

To conduct our analysis, two different datasets were collected for the year 2019: 1) Calgary Road Network (from the City of Calgary Open Data Portal) and 2) Calgary OSM Road Network. The OSM data were extracted using OSMnx, which is a Python package that enables users to download geospatial data from OpenStreetMap and model, project, visualize, and analyze real-world street networks (Boeing, 2017). Both datasets consist of different road classes and attributes across the city. The Calgary road network data from the city was considered preprocessed and exact (without error) since it was our base reference, and the project's objective was to compare the accuracy of OSM with administrative data.

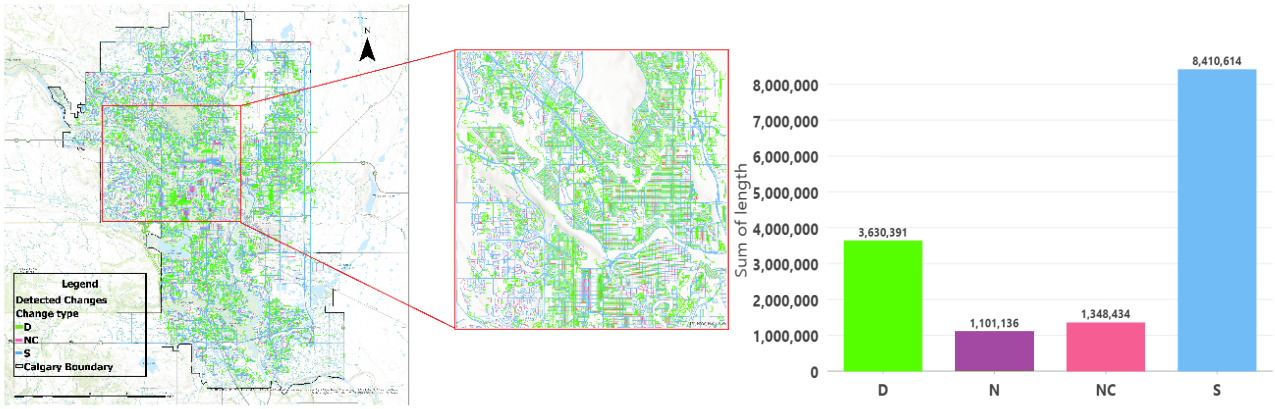
In order to assess the data completeness and positional accuracy, geometric feature matching was performed to identify unmatched segments of roads from the OSM dataset and the city of Calgary road networks. Geometric feature matching was done by using the “Detect Feature Changes tool” in ArcGIS Pro with a search distance of 50 meters and a change tolerance of 5 meters. Firstly, it is crucial to confirm that two datasets have the same projection to conduct a geometric feature matching. The projection here is the "Traverse Mercator,” which, in this case, is valid for both datasets. The city of Calgary dataset was used as a base layer/benchmark. As the main result of the "Detect feature changes" tool, "Change Type" tells what types of changes have been detected. Figure 1 (a) below displays the map of the results of Detect Feature Changes. As shown in Figure 1 (a) and its magnified image, it is easy to identify which segments have the highest proportion among the others. The proportions of the line segments (in order of highest to lowest) are shown in the figure: green, blue, and magenta colors of lines. Figure 1 (b) below shows the total length of road segments for each change type. The OSM dataset contains about 1,100 kilometers of roads that do not exist in the city dataset, and the city dataset contains nearly 3,600 kilometres of roads that do not exist in the OSM dataset. It is estimated that a substantial proportion of roads (nearly 10,000 kilometers) are either exactly the same in both datasets or are matched with a spatial change in position. Therefore, it is clear that OSM is relatively accurate in this case. In order to further estimate the accuracy of the OSM dataset, the positional accuracy of the OSM dataset is required.

To thoroughly examine the OSM dataset's accuracy, the Calgary OSM dataset's positional accuracy was assessed using the buffer analysis while setting the city of Calgary road networks as a benchmark with a range from 1 to 10 meters. The assessment took into account the exact OSM layers, including living streets, motorways, primary, residential, roads, secondary, tertiary, trunks, and unclassified. In addition, for the Calgary road network data provided by the city, the following road types were considered: skeletal road, local arterial, industrial arterial, arterial street, access route, urban boulevard, neighborhood boulevard, parkway, alleys, residential street, collector, primary collector, and activity center street.

Abstracts of the International Cartographic Association, 6, 124, 2023.
31st International Cartographic Conference (ICC 2023), 13–18 August 2023, Cape Town, South Africa.
https://doi.org/10.5194/ica-abs-6-124-2023

These exact OSM layers are matched with different types of roads from the city of Calgary road networks. All different road categories in both datasets are combined into three major categories (Class 1 – Local, Class 2 – Arterial, and Class 3 – Skeletal). There is a logarithmic increase in positional accuracy for nearly all classes of roads. There is an average positional offset of 2.3 meters. In the case of a buffer of 1 meter, the positional accuracy ranges between 14% and 49%. There is a relatively rapid increase in accuracy until 6 meters. After that, accuracy gradually increases. More than 86% of road segments have positional errors within 5 meters. For a buffer size of 10 m, classes 1 and 2 have a positional accuracy of over 90%, and class 3 shows around 80%. Figure 2 below shows the overall trends of the OSM Calgary road network's positional accuracy. In general, different buffer sizes will be selected depending on the target accuracy of the research or project. Based on our research findings, with a minimum buffer size of 5 m, more than 80% accuracy can be achieved.

This work aimed to evaluate the quality and reliability of the Calgary OSM road network map. For users, VGI data quality assessments are a crucial step since they provide the basic information they need to determine whether VGI can be used in their applications. In order to assess the quality of the OSM road network in Calgary, we measured and estimated the data completeness, attribute relatedness, and positional accuracy. Despite the fact that the quality of OSM road networks may vary based on a variety of factors, including the size of datasets, locations, and attributes, the approaches and findings from the research can provide valuable information to individuals, organizations, non-profits, governments, official mapping organizations, and more when selecting road network mapping products and to have a better understanding of OSM quality assessment.



(a) (b)

Figure 1. The Results of Detect feature changes. "D" refers to segments that exist in the city data but not in OSM, "N" refers to segments that exist in OSM but are not present in the city dataset, "NC" refers to segments that are exactly matched in both datasets, and "S" means segments that are matched with spatial changes. (a) The map of Detect feature changes results with a magnified area. (b) The results of Detect feature changes show the total length of street segments for four change categories.

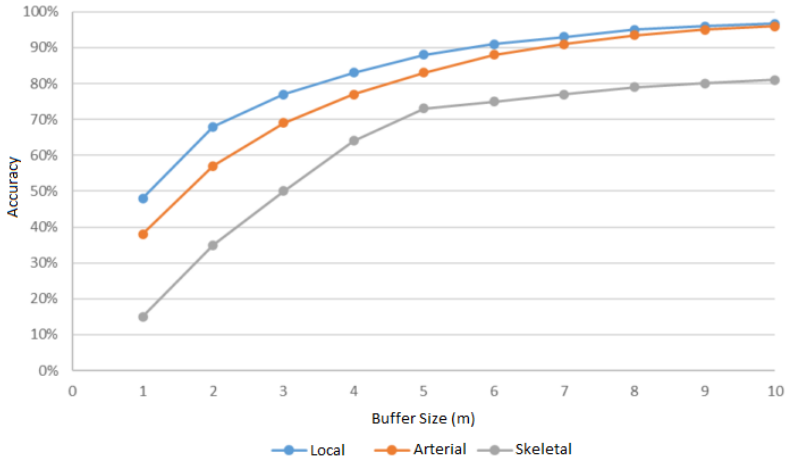


Figure 2. Trends of the OSM positional accuracy

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Road Network Data Sources:

Calgary Road Network: https://data.calgary.ca/Transportation-Transit/Major-Road-Network/mybc-x96b
Calgary OSM Road Network: https://www.openstreetmap.org/#map=7/35.948/127.736

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