Drone Imagery for OpenStreetMap Sidewalk Data Enrichment

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Abstract. Several Location Based Services (LBS) are developed from open sources. The OpenStreetMap (OSM) is most stable and used one and, besides being open data source, has a collaborative characteristic, known as Volunteered Geographic Information (VGI). In this context, some routing services have emerged supported by LBS and VGI, and personalization has become a trendy. However, customization as wheelchair and pedestrian route planning requires specific and detailed information about sidewalk. Currently, most sidewalk in OSM are nearly missing or tags absent. Besides that, there is a lack of standardization for mapping this data. In a first moment, this study was developed aiming to fill this gap by using remote sensing, specifically Drone. The procedure for data enrichment proposed consists of: (i) data completeness search; (ii) data acquirement and processing, and (iii) data availability. The initial results showed that the pilot area has a high degree of incompleteness and, once drone imagery was provided, sidewalk could be mapped based on the resulting orthomosaic. The next step will be a study targeting sidewalk tags and features pattern definition. At the end of this study, besides the exploration of the possibility of high quality imagery sharing, sidewalk standardized mapping may improve location based services data for engines, such as wheelchair and pedestrian routing.

Keywords. Location Based Service, Volunteered Geographic Information, OpenStreetMap, Sidewalk, Drone, Remote Sensing.

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1. Introduction

There has been several innovations and applications for drones – or unmanned aerial vehicles (UAVs) – among location based services (LBS). Technology development has increased its uses in urban areas, mainly approaching buildings and streets mapping tasks in order to provide information for LBSs (Alwateer, Loke, and Zuchowicz 2019).

Despite is unlikely that everyone will have a drone - as happened with the smartphone spread phenomenon - there is a trendy that drones will integrate a range of location based services in different ways. For example, there are already companies offering drone products and services. (Alwateer, Loke, and Zuchowicz 2019).

Open sources engines has also incorporated drone technology, exposing new possibilities for Volunteered Geographic Information (VGI). In this context, OpenStreetMap (OSM), which is the most widespread VGI project, allows high quality aerial imagery - including drone – visualization. The images can be uploaded at OpenAerialMap[2] (OAM) and then used as a layer at OSM editor (online or Java OSM App - JOSM).

Currently, OSM is supported by Bing imagery layer, which provides resolutions up to 15 meters depending on world location. In contrast, drones can reach an average of 10 ~ 15 square centimeters per pixel, depending on different aspects, being flight altitude and camera type the most decisive (Domingo et al. 2019).

This level of resolution would allow users to map details undistinguished at most common satellite images. Sidewalk is an example of limited feature to be outlined utilizing low-resolution image, aspect that could be attenuate by using high quality images.

In the case of sidewalk in OSM, there is a recurring case of completeness related to lack of data. This is a result of sidewalk being mapped as a street tag ("yes", "no" or "both") until 2016, ignoring sidewalk characteristics such as width, surface, incline and accessibility. Just recently sidewalks have started being mapped separately (Neis and Zielstra 2014), mostly due to remote mapping complications. In other words, OSM sidewalk identification task rely on local users, whith site knowledge.

According to Zipf (2016), completeness of data is one of the most relevant aspects towards LBSs. Van Oort (2006) refers to completeness as both missing/defective data and extra/overlapping data, being the first one called incompleteness and the second one overcompleteness.

[2] https://openaerialmap.org/

OSM data incompleteness can be measured in different ways. The tool OS-Matrix[3], which is no longer available, was able to calculate the number of objects of a selected featured. One tool widely used that is still available is OSM Quality Assurance[4] that can identify ways and streets without tags, being able to highlights streets without sidewalk tag.

Nevertheless, none of these tools interacts with sidewalk data mapped as an independent feature. Approaching this issue, an engine available at uMap[5] is able to highlight in screen sidewalks in this way.

Additionally, the knowledge of what must or must not belong to the complete set of data is imperative (van Oort 2006). In simple words, for wheelchair and pedestrian routing proposes, besides knowing if sidewalks were mapped, we need to know if the OSM tags were properly assimilated.

The present study approaches a possibility for sidewalk data mapping using a remote sensing technique based on the unmanned aerial vehicle Drone. The central idea is to evaluate the methodology potential by updating the imagery product to OAM, allowing OSM users to incorporate orthomosaics as a layer during collaborative mapping. We choose a central city area in Brazil, in São Carlos municipality (São Paulo state) as a pilot study.

2. Methodology

In this section, we discuss the method used for OSM sidewalk data enrichment developed in a pilot area located in an inner city of São Paulo state in Brazil, São Carlos urban central area (22°01'S; 47°53'W).

The proposed procedure aimed remote sensing OSM edition and comprised three main steps: (i) data completeness search; (ii) data acquirement and processing, and (iii) data availability.

Completeness search consisted in a real-time OSM data checking process performed in “uMap - Pedestrians Overlay”, focusing on verifying the need for sidewalk features enrichment.

Once confirmed some level of incompleteness, data acquirement started using the unmanned aerial vehicle DJI Phantom 4®. This quad copter Drone was equipped with a camera with the following specifications: sensor 1/2.3” (CMOS), effective pixels:12.4 M, lens FOV 94° 20 mm (35 mm for-

[3] https://github.com/GIScience/osmatrix-client

[4] http://editor.osmsurround.org/

[5] http://umap.openstreetmap.fr/en/map/pedestrians-overlay_21247#6/51.000/2.000

mat equivalent) f/2.8, focus at ∞, image size 4000x3000, photo format JPEG, DNG (RAW) and approximate focal length 3.61 mm.

Then, data was processed through Maply[6] online platform. The resulting orthomosaic was made available online in OAM. Once available there, sidewalk features and tags could be designed at OSM online editor.

3. Preliminary Results

The initial and the final search regarding completeness are presented in *Figure 1a*, scanned before data enrichment, and *Figure 1b*, scanned after data enrichment.

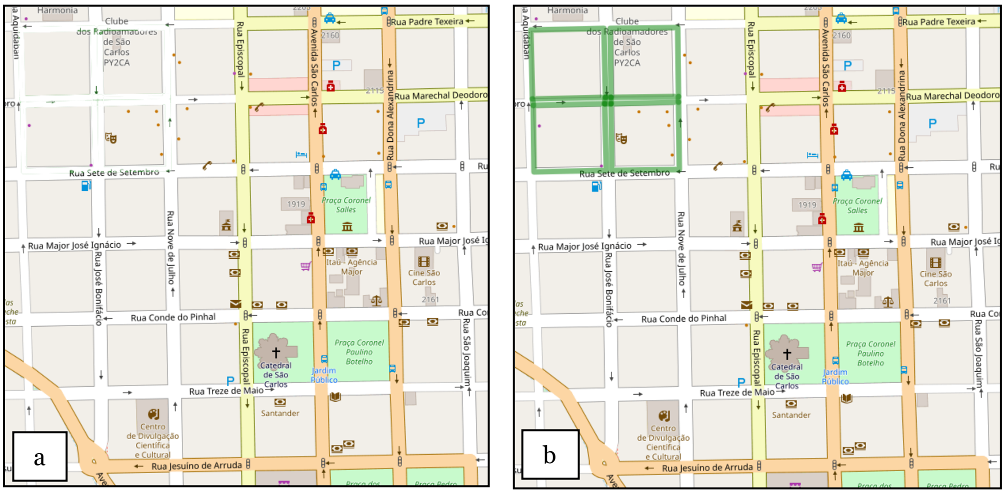

Figure 1. Study area scanned around completeness. Green lines (in b) shows sidewalks mapped separately (uMap, 2019).

In *Figure 1a* none sidewalk mapped separately was identified, meaning a high degree of incompleteness and, therefore, being suitable for data enrichment. *Figure 1b* represents the same measurement after a testing sidewalk mapping at OSM using the resulting drone imagery as a base map layer, exposing the effectiveness of the measurement method.

As proposed, data acquirement was performed imagining approximately 0.4 square kilometers, with 80% of longitudinal and 70% of lateral overlap. The orthomosaic photo obtained resulted in a ground resolution of approximately 0.12cm^2/pixel, a 28137 x 25920-pixel resolution and an 8-bit radiometric resolution (see a fragment of it in *Figure 2b*).

[6] Complete platform for drone data processing: https://www.maply.io/.

Once orthomosaic was produced and made available on OAM platform, and since sidewalk could be visually distinguished and mapped by OSM users, the next steps are working on sidewalk tags and features pattern definition.

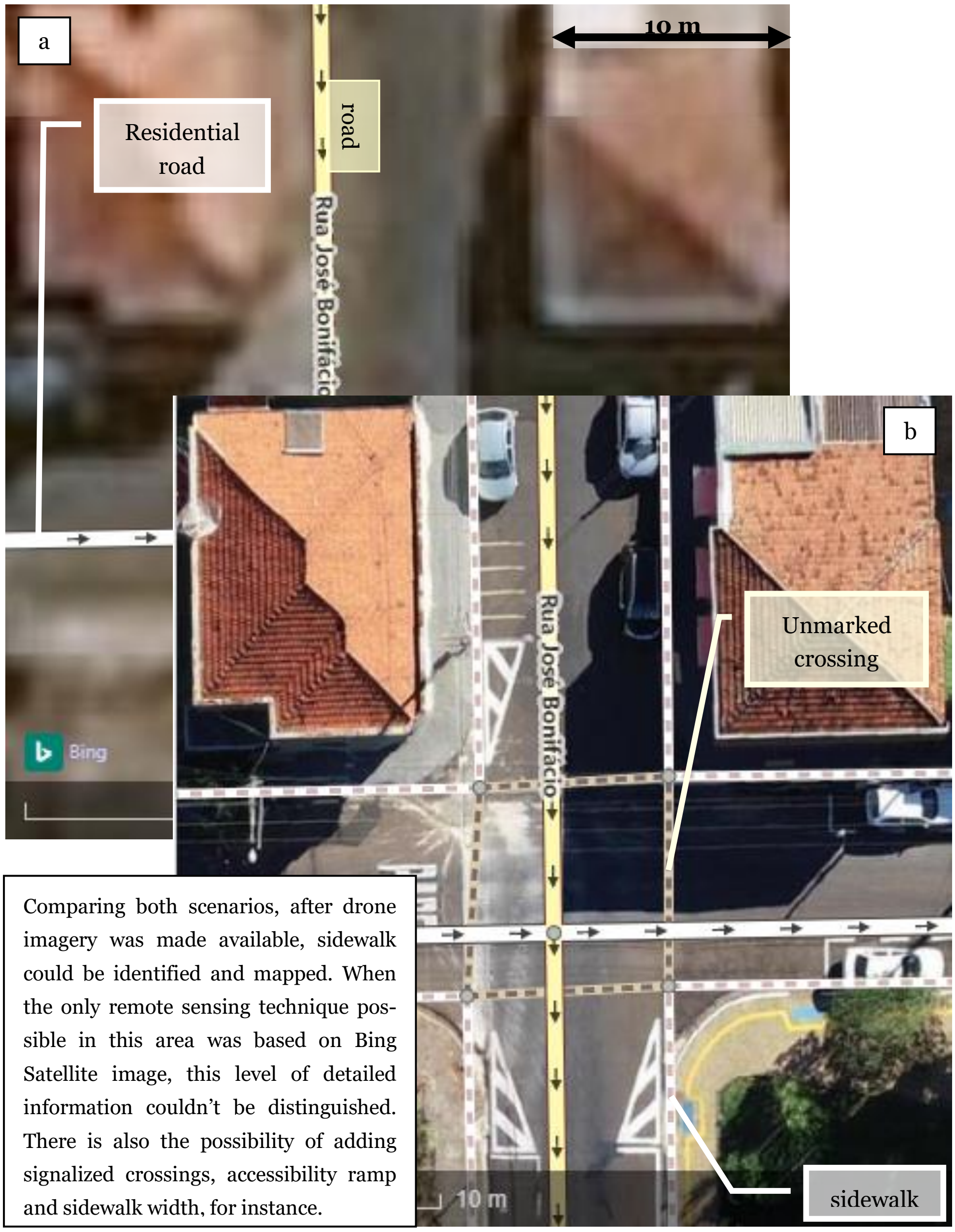

Figure 2. Study area view at OSM. In a: Bing base map. In b: orthomosaic obtained from Drone imagery, available in OAM (search for "São Carlos Brazil").

4. Final Considerations

The main output from these initial steps is the possibility of high quality imagery sharing and the potential of data supplying for LBS through collaborative mapping in open source engines. Specifically regarding sidewalk information, open LBS aiming pedestrians and wheelchair routing, for example, could improve their functionalities.

Among the study area, considering the lack of quality imagery for remote VGI edition on OSM and the absence of sidewalk and crossing features, the proposed methodology went beyond enrichment.

It is important to emphasize that there are other methodologies for sidewalk mapping on OSM, such as GPS tracking and data mining techniques as proposed by Mobasheri et al. (2018). However, both techniques should be supplementary to each other once one is dependent on UAV photography availability and the other one requires on site presence/knowledge.

Another relevant point refers to the next steps of this study: features and tags definition. Among OSM community there are some standard issues regarding sidewalk. There was an agreement, that sidewalk may be mapped separately. Although, there are some discussions about accessibility ramps, which are tagged as kerbs “lowered” or “raised”, and marked crossings, which are featured as ways or nodes depending on user preference.

References

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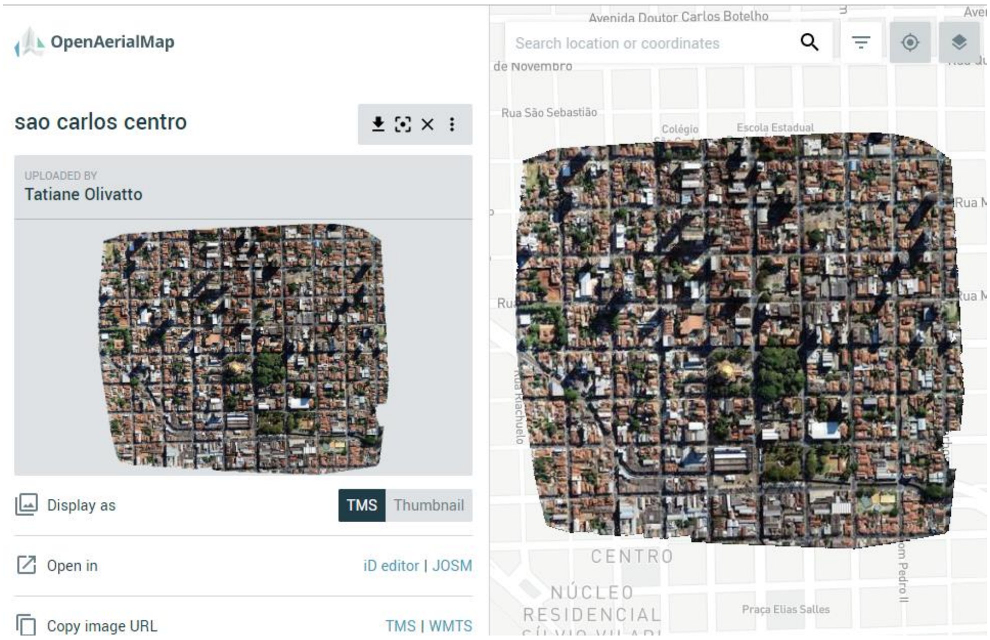
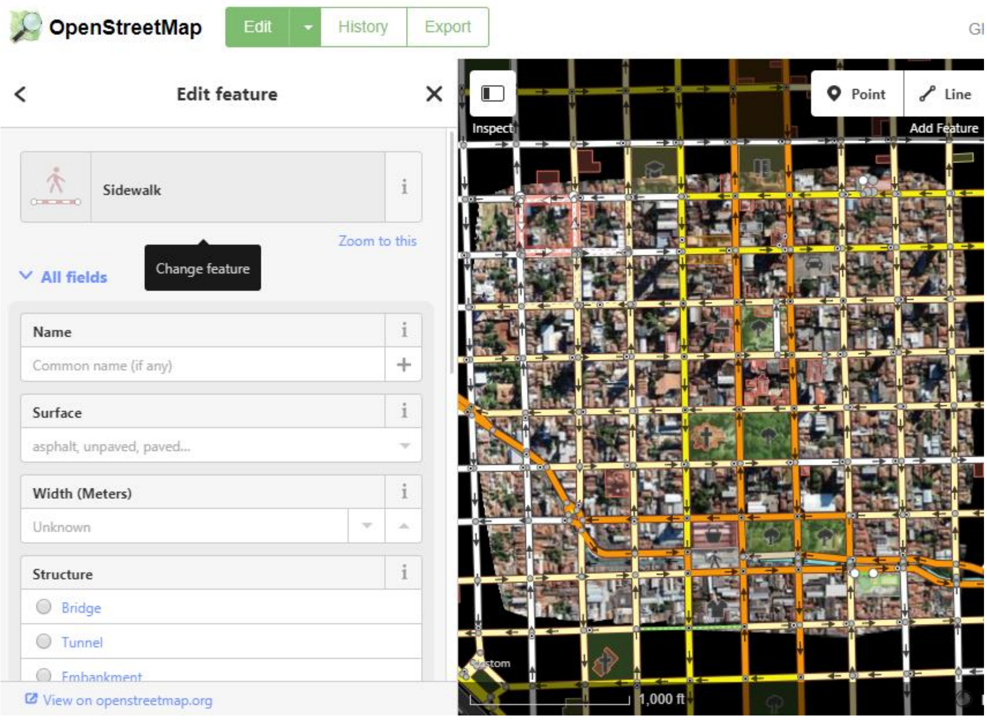
Appendix



Orthomosaic at OpenAerialMap.



Orthomosaic at OpenStreetMap Editor.