In search for urban landscape development tools: Street View Imagery (SVI) Analysis

Anas Tuffaha
Hungarian University of Agriculture and Life Sciences (MATE)

1. Abstract

Streets hold up to 90% of public space in densely built urban areas, they are ubiquitous and thus hold considerable spatial potential to fulfil various functions. This paper presents a comparative study on main streets, squares, or spaces on a micro scale within Budapest and compared to similar European streets.

A goal to transform streets into sufficient public spaces for a growing number of people are investigated along with how residents view those spaces from their own point of view. A motive and evidence for its importance is focused on how half of the world's population is now covered by Street View Imagery (SVI), which provides a valuable large-scale source of urban data, often replacing field visits with virtual audits and it can be a vital resource to help us design and understand how we could perceive our landscape and urban spaces especially.

The questions of this paper are the following: Could we use street images and analysis for urban and landscape development? Are our perspectives and what we see from images efficient tools to develop our surroundings? Is Google Street View Imagery (GSVI) an effective tool to analyse, categorize and compare our public spaces and streets in relation to landscape and urban developments?

Finally, this paper will take a look at how GSVI works, its positives and negatives, then use previous literature and studies to apply a practical analysis using GSVI. A figure with an assessment method to see how we could use GSVI and image editing programs to end up with quantitative results that could be used for landscape development and comparative analysis within our streets and public spaces. The importance and historical use of GSVI is evident in research and literature, the questions lie in how and what methods could make it of good assistance and use in our profession and its applications.

Key words: Landscape assessment; Street greenery; Google Street View Imagery (GSVI); Visual quality, public participation

2. Introduction

Street imagery is a tool that provides real-time panoramic imagery to different spots needed within a map (Chen, 2019). The virtual representation of our surroundings used in platforms such as Google Maps, consisting of millions of panoramic images is the core of Street View's content which comes from sources like Google and other contributors (Rundle, 2011) Street view imagery (SVI) has gained a strong momentum in urban studies in the last few years. Such development was largely propelled by the proliferation of SVI data (coverage and development of services such as GSVI).

A main factor behind this rise is the advances in machine learning and computer vision that enable extracting a variety of information automatically. These advances are resulting in growing computing powers that facilitate processing abundant images until this day (Anguelov,2010)

Just like how GIS has been used to provide yearly changes in vegetation, provide detailed changes within a map or plan view, and give a high-quality insight that has been used until this day by urban planners, designers, landscape architects and governments (Gonzalez, 2020). Street imagery analysis could be used in the same way providing a front view and a panoramic image of the needed area. In this research, Open Street Map and Google Maps aerial views give insight from aerial perspectives, while street view imagery function as a basic elevation view or a panoramic point of view. This perspective in my paper provides us with insight on how we could use street imagery as a phase to design, Analyse and understand our urban spaces and landscape designs better within Budapest and other cities.

There are only a few objective methods for measuring urban greenery and this is an important factor in my study since it aids in the development of our streets and landscape. Remote sensing seems to be a common method for measuring urban greenery (e.g., Gupta et al. 2012). This is probably due to a few virtues like repeatability, synoptic view, and larger area coverage. While green indexes derived from remotely sensed data may be good for quantifying urban greenery, they are poor at assessing profile views of urban greenery at street-level.

There are many methods to understand SVI and analyse it, one example I have used as an inspiration for this subject is “Street DNA” the author in the university of Sheffield gave people designed glasses to see what people look at, to capture visual engagement with urban street edges.

This method helps to understand what people look at to project urban and landscape developments and, in my study, this could take place from our street elevations and imagery (Simpson, 2018).

The next figure shows a quick glimpse on how cityscape elements can be perceived differently depending on how we perceive an image from a bird’s eye view or from the side.

Figure 1. Showcasing how vertical greenery is clearer in a street view.

My study area is mostly conducted in Budapest, the street map of the study area was processed and generated based on Street View imagery, from google maps and used as a basis for the research.

The main goal in the study is to use these images to assess their validity in a simple method that provides green areas percentages to study and compare. This process gives a clear objective to define the efficiency of GSVI analysis in the decision support of landscape development plans.

3. Background and Literature Review

There are dozens of street view services, most of them are regional covering one or a few countries.

1. Google Street View (GSVI): is by far the most well-known and widely used SVI service. Since its inception in 2007, Google Street View has expanded to cover more than 90 countries, as well as indoor spaces. The service is available via a web interface that integrates Google Maps, smartphone apps, and an API.

2. Crowdsourced services: The remaining two services with a global focus are Mapillary and Karta View. They are both commercially owned and operated and rely on crowdsourced imagery. They are described together due to their inherent commonalities, Baidu Total View, and Tencent Street View (China): Following an overview of SVI services with a global focus, this section focuses on local instances as further examples of SVI services. A significant number of articles in China were conducted utilizing two SVI providers: Tencent Street View and Baidu Total View.

Throughout many studies we have seen close approaches and analysis to the same theme, for example we know that people's perceptions of street vegetation play a significant sensory role. (Ulrich, 1984) Urban Street greenery makes an important contribution to the attractiveness and walkability of residential streets (Ulrich, 1984). The existence of vegetation usually increases people’s aesthetic rating of urban scenes. People’s accessibility to views of greenery seems to influence their recovery from surgery and increases restorative potential (Ulrich, 1984).

This study inspired many future papers to analyse the effect and the percentages of green areas in our streets and spaces, some applications were observed by stitching pictures together, GSVI can create a continuous 360-degree image of a streetscape. In fact, the GSVI library has been proposed as an effective potential source for urban studies (Rundle et al., 2010), for 3D modelling, space audits and urban planning (Rundle et al., 2011). In the study the researchers used four photos shot in four directions stitched to be studied and analyzed. This study has been helpful for us to begin assessing our greenery using a similar method, where they conducted field surveys in Berkeley, California, and combined these with photography interpretation. Results showed that their proposed GSVI was efficient in evaluating the visual effects of various planning and management practices on urban forests.

In 2015, students at university of Connecticut and Beijing’s Remote sensing departments, had a similar study using google street imagery. The study used black and white indexes using photo filters to investigate the percentages of green areas in the image (Xiajiang, L., 2015). The previous study was Based on the analysis of the spectral information of green vegetation on selected GSV images, which found that the green vegetation has high reflectance at green band and relatively low reflectance at both red and blue bands. Using this they can separate the green color to show in images in a black and white mode.

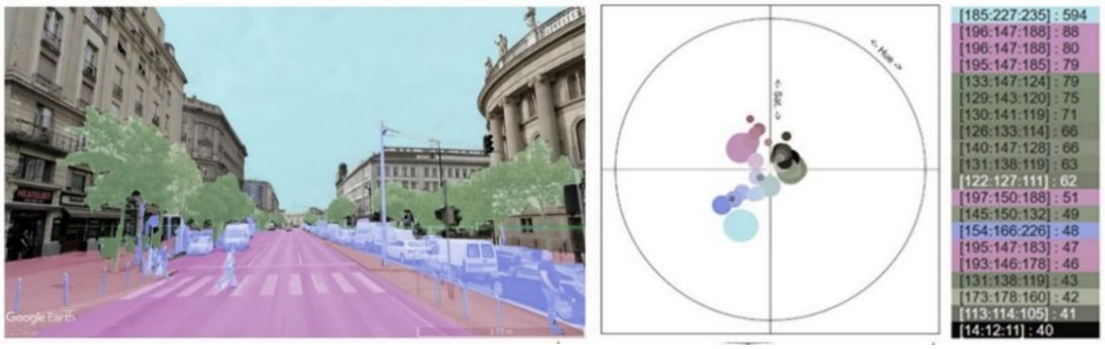
I have used this method as inspiration in my paper with Adobe Photoshop where I have separated the color shades and used identifiers to give percentages and differentiate objects.

4.Method and Data

To begin with understanding the green area quantity or ratio in our perspectives which are taken from Google Street View Imagery, the images are taken in a position of human perspective borrowed from GSVI then taken to analysis. The focus is on the green colour compared to blue and red lines where filters are subjected to change using any high quality photo editor or separator, in my situation I have used Adobe Photoshop to filter colours into black shades. This method of colour filtering and keeping the greenery could be done in many different ways if you have photo editing expertise, one way is the following: The main image is duplicated, then desaturation option to the maximum is used, next the colour range option from the option toolbar is picked which will help to choose the colour range. An important tip I usually follow is selecting multiple points which allows me to add multiple shades of green to the sample.

Figure 2. Showcasing my process of filtering greenery in GSI using filtering and editing tools.

The more shades I capture with the "Add to sample tool", the more accurate my effect will be.) Finally, the invert image tool will end up with the result needed, if another desaturation option to the green colour is added we end up with result 02 which is in pure black and white form. This method creates the images as seen from 01 until 03 ending with an inverted filtered colour that gives an outcome that focuses on our green areas.



	Percentage of perspective in GSI
Sky	34%
Green	5%
Pedestrian Walkways	22.5%
Buildings & Construction	35.5%
Objects & Street Furniture	3%

Figure 3. introducing my approach of filtering the whole image into separated and numbered colours in IDs to distinguish different objects in a GSI and measure their percentages

Adobe Photoshop gives a wide range of opportunities to create photo filters and image editing options to create a percentages study or analyse the images.
Another example I have used creates more intricate ways, that eventually lead to a detailed ratio of colours and objects we see; this is the second method I have used (Figure 3.). The colour filtering or separation method is a main part of this paper, it consists of the same method of creating the black and white images but in a more complex process.

Using Adobe Photoshop, the same method of duplicating layers and decreasing saturation is performed, this time several colours are made, the first is green, using colour range option for all colours are desaturated besides green. The layers are then duplicated, and the sky's blue colour is used in the colour range while others are desaturated. This method is replicated and repeated to create different colours for each element in the image.

Finally, Greeneries, sky, walkways, buildings, and street furniture are elements to analyse and see. Using the plenty programs or methods that count colour pixels in images such as colour proportion maker. A graph shows colours in the image and their percentages.

5. Result and Conclusion

The study area chosen, has been analyzed in different locations, In the next sentences I summed up what kind of results could be concluded from the different samples provided.

1. Vacant land with a Vertical Green wall element. In Figure A we can use the elevation view to study the vertical green spaces and their management in our facades.

2. Tree alley along the road. In Figure B, an analysis of Bajcsy-Zsilinszky út 19 showcasing the abundant greenery on both pavements.

3. Comparative roads in different European cities. Figure C, D and E show how we can provide a comparison in studies to analyze cities, comparing street depth, street views, objects, greenery and vegetation and their overall proportion, here the fashion street of Budapest, Vienna and Munich are taken from GSI in different locations. Figure C has a single tree along with more objects, Figure D showcases no vegetation and more building-oriented street view compared to E.

4. Dense Tree Alley along the road. Figure F (Andrássy út) one of the richest streets regarding its landscape and vegetation, Holding around 40 percent of a street perspective with green cover.

5. Square with some vegetation and a Transportation Stop. Figure G introduces the abundance of components in our perception, the streetscape components within the urban fabric in addition to us moving, the trams, cars and street furniture all pilling in one perspective. The colour filter and analysis end up showing what each part of the streetscape take, for example trams, cars and moving objects on the oktagon stop form 10 percent of the GSVI, balancing with the green areas.

6. Park with Situational project. Finally, Figure H (Sou Fujimoto's house of Hungarian music) is another assurance for the benefit of GSVI being a tool to develop landscapes within our urban

fabric, sheltered and tent like structures don't provide a detail overview of the green area's distribution using top views since they are obstructed.

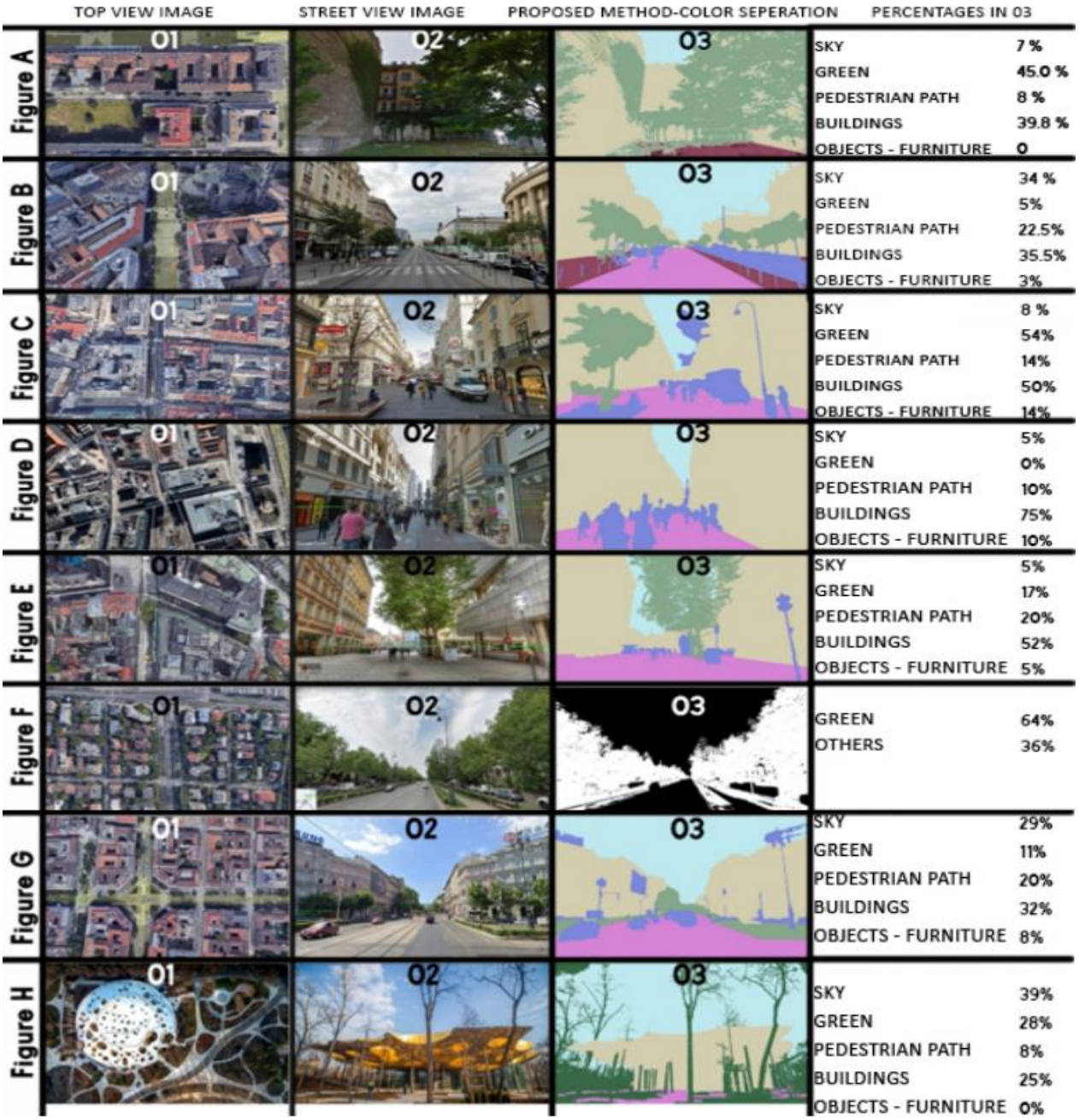


Figure 4. Reveals different case studies in varied locations used to analyse the method of separating colours using programs to assess GSVI as a tool for analysing our streets.

Through analysing such graphs, an initial result shows that we could as an answer analyse our streetscape and landscape using SVI. In fact, landscape development is in synch with such method and ends with fundamental results, In the graph analysed and locations studied, I have reached different results from analysing the images provided from GSVI without any personal visits:

- green areas are measured proportionally in each image, and percentages of different elements in the streetscape in our sight are provided with ratios after assigning colours to each element in the SVI, these results are practical and easy to quote and use.
- The diverse locations in Budapest provided a green area in the perception ratio ranging from 10% to 60%. Each location uniquely, could be measured and developed.

- Streets with many trees along the alley proved to have the greenest areas in perception but also covered other objects, buildings and streetscapes taking most of our vision to it.

- Comparative studies are easier to make using this method, percentages in each street or similar locations prove to be comparable. For example, in the graph GSVI images from Budapest's fashion street, and on the other hand Vienna's for green spaces and streetscape show a close ratio of elements in the photos, while München's GSVI has a higher ratio.

- Squares are the most diverse of the study with a large number of elements are in our sight, green take 11 %, streetscapes take 8 % while the overall image is varied in outcomes.

- Courtyards, cantilevers covering green spaces, and indoor areas are compatible with this method, green areas in an elevational view give a more detailed result than top views since they are obstructed in the top view.

6. Discussion and Outlooks

The method used in this study is subjected to various factors that affect the outcomes and its applicability. The most significant factors are discussed in the following sentences:

- The images are not always available. In Budapest most main streets have evident images, unfortunately towns, many locations around the world would need 2/3 more years to develop such images according to google analytics. Google started allowing people to contribute to the images for years, increasing the speed of developments.

- The availability of historical images could introduce a helpful efficient comparative data base, in addition to that, more detailed outcomes could be produced when images are taken at different times, an average result could be made and in this way a result that fits different times and seasons is valid.

- Participatory design could be easier for our community since images are simpler and clearer. As seen in figure 5, in which participatory design could be a classical method to improve and develop designs with the community and the designer, changes could be easier since the images are clearer and the method, I have used could give instant results to compare and analyse results, I have used this example in increasing the green areas in figure 5 as a demonstration for the capabilities of participatory design in this method.

- when making comparisons with streets or any locations, several images should be analyzed and not one, since the result of several images will be more detailed as in one GSVI image green areas or vehicles could be obstructed.

- This method could save time and money instead of visiting the location needed especially after the pandemic case. The effectiveness comes not only because it saves time, but also a legitimate method to analyze pixels of photos by assigning colors to each element. The proportions can be used in many varied studies like scale, proportion, and developments.

7. References

Alhasoun, F. (2019). Streetify: Using Street View Imagery and Deep Learning for Urban Streets Development.

Anguelov, D., et al. (2010). "Google Street View: Capturing the World at Street Level." IEEE Computer 43: 32-38.

Berland, A. (2016). "Google Street View shows promise for virtual street tree surveys." Urban Forestry & Urban Greening 21.

Biljecki, F. (2021). "Street view imagery in urban analytics and GIS: A review." Landscape and Urban Planning 215: 104217.

Chen, X., et al. (2019). "Evaluating Greenery around Streets Using Baidu Panoramic Street View Images and the Panoramic Green View Index." Forests 10(12).

Gong, Z., et al. (2019). "Classifying Street Spaces with Street View Images for a Spatial Indicator of Urban Functions." Sustainability 11: 6424.

Gonzalez, D., et al. (2020). "Automatic detection of building typology using deep learning methods on street level images." Building and Environment 177: 106805.

Li, X., et al. (2017). "Quantifying the shade provision landscape: A case study in Boston, USA, using Google Street View." Landscape and Planning 169.

Rundle, A., et al. (2011). "Using Google Street View to audit neighbourhood environments." American Journal of Public Health, 40.

Simpson, J. (2018). "Street DNA: the who, where and what of visual engagement with the urban street." Journal of Landscape Architecture 13: 50-57.

Ulrich, R. (1984). "View Through a Window [Influence Recovery from Surgery." Science (New York, N.Y.) 224: 420-421.

Xiaojiag, L., Chuanrong, Z., Robert, R., Weidong, L., Weixing, Z., (2015). “Assessing street-level urban greenery using Google Street view.” Urban Forestry & Urban Greening 14