Feature Changes of Selected Cebu City Landmarks: Forms and Roughness Analysis

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Abstract

The study aims to examine the physical change of the old and new photographs of selected Cebu City landmarks. The images were converted into a binary image using the simplest form of image processing known as thresholding effect. The binary image provides a simple view and ease for computing its fractal dimension. The fractal dimension explains the space-filling property of the image. The change of the fractal dimension between the old and new image may be attributed to a number of factors such as environmental change, local development agenda and legislative clarity.

Keywords: binary image, thresholding effect, fractal dimension

1.0 Introduction

Cebu City is at the heart of the Philippines. Being in a strategic location makes it ideal take off point for business, travel, tourism, and transportation, particularly shipping. Because almost all of its inhabitants are Roman Catholic, it is considered as Asia's Cradle of Christianity. The place is also famous for its extraordinary role in the furtherance of democracy as well as transparency in public administration and government even before the Spaniards, Americans, and Japanese arrived in the country until the present. In terms of academic performance, it has produced numerous professionals who have become leaders of great vision and influence among academic circles, civic organizations and local politics.

Also known as Queen City of Southern Philippines, it has a number of landmarks that are vested with historical and cultural significance that continuously draw tourists from domestic and foreign origins. Five of these landmarks are the Cebu International Port (including Radisson Blu Hotel and SM City Cebu), Cebu Provincial Capitol, Robinsons Mall andFuenteOsmena, Rizal Memorial Library and Museum, and the Basilica Minore del Santo Nino.

Recognizing this, the researchers have chosen to scrutinize old and recent photographs (that spanned an average of over ten years gap) of the five landmarks that encapsulate Cebu's history, trade and commerce, tourism industry, and shipping. Not contented by just merely looking in plain view whether the pictures are clearly the reproduction of reality, the researchers subjected the pictures to further analysis. This is to establish a scientific basis to describe the ruggedness and variations of the physical changes overtime in Cebu.

Specifically, this study aims (a) to examine the fractality of physical changes of the old and new photographs of selected Cebu landmarks as to their physical changes; (b) to validate the physical changes of the old and new photographs using documentary pieces of evidence from government agencies and other entities; and (c) to give implications from pertinent findings which may suggest measures for improving legislative policies

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and decision-making related to urban planning and development.

One way of analyzing a picture is by means of fractal analysis using image segmentation (IS) which is the process of partitioning a digital image into multiple segments, otherwise known as sets of pixels or superpixels that are similar in characteristic such as color, intensity, contours, and texture. Image segmentation is done (1)to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze; (2)to locate objects and boundaries (lines, curves, etc.) in images; and (3) to assign a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The four of the various IS methods are (a)thresholding, (b)maximum entropy method, (c)Otsu's method (maximum variance), and (d)k-means clustering. The simplest among the four is thresholding, which is based on a clip-level, or a threshold value, in turning a gray-scale image into a binary image.

Unlike classic statistical analysis, fractal analysis in image segmentation gives a more precise dimension of the ruggedness or irregularity of the shape of the object under scrutiny. This is a form of image processing in which the landscape in the picture is analyzed using the principles of fractal geometry originally espoused by French Benoit Mandelbrot, a great mathematician who since his childhood had love for visual arts. Lopes and Betrouni (2009) focused on texture in image segmentation analysis in two ways. One method is based only on fractal and/or multifractal features, while the other method combines fractal and/or multifractal features with other texture features.

Image analysis has been used in medicine especially in arriving at the right diagnosis of a patient's illness. Among the imaging modalities used for diagnostic purposes are chest radiography, mammography, ultrasound (US), computed tomography (CT), single photon emission computed tomography (SPECT), positron emission tomography, and magnetic resonance imaging (MRI). Aside from diagnostics, it is also used in making 3D reconstructions with the help of interpolation algorithms such as marching cubes.

In the same manner, texture segmentation using fractals has been used by many researchers to describe spatial patterns in a variety of landscape-level applications (Burrough, 1986; O'Neill et.al., 1988; De Cola,1989; Lam, 1990; Milne, 1990; Rex and Malason, 1990; Turner, 1990; Polidori et. al., 1991; Ripple et.al., 1991; Baker and Cai, 1992 as ctd in Olsen, Ramsey, & Winn, 1993).

Considering the principles of fractality, image segmentation, and texture segmentation, the researchers have chosen the old and new photographs of Cebu City's North Reclamation Area where Radisson Blu Hotel, SM City, and the international port are nestled. These were chosen because of their prominence in tourism, commerce and trade and shipping. Six years back, Cebu was declared by the government as the hub for tourism because it has more tourist arrivals over other areas in the country; business hub (especially for business process outsourcing (BPOs) and other IT-enabled industry) being the place where some of the business tycoons of the country like Henry Sy, John Gokongwei and Lucio Tan first started their entrepreneurial skills, and as the country's maritime hub being the island where most of the shipping companies are situated as the converging point of all major shipping companies in the country. These are also places that have gained popularity not only among Cebuanos but also of travelers who have gotten to like Cebu.

Fractal analysis is used in this study to accommodate the ruggedness of the shapes of the buildings, mountains, trees (if applicable), ships, and even vehicles found in the pictures.

2.0 Methodology

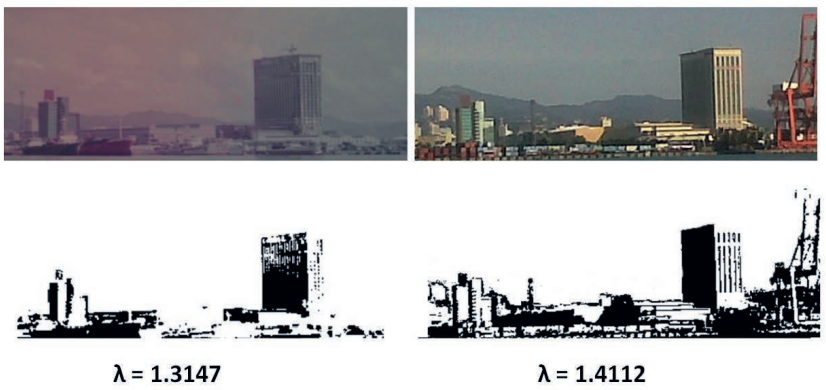
The study utilizes Comparative Tempo-Spatial Pattern (CTSPA) Analysis using fractal geometry. This is a new method used in characterizing urban pattern changes over different time (Xie& Ye, January2007)periods. This method, along withthresholding in image segmentation and texturization are employed to further dissect the photographs of the different landmarks taken decades back against those shots taken lately.

3.0 Results and Discussion

The photographs below are the collected images of the Cebu landmarks subjected to image processing-thresholding (Otsu's method) using fractal methodologies. The original pictures are first presented followed by the segmented images in which the fractal dimensions (λ) are computed then dimensional changes between the old and new photographs are analyzed.

As shown in Fig.1- Cebu International Port – From afar, the port pictures show a less vibrant and less orderly port and container yard contrasted to a highly vibrant and well-ordered container yard peppered with structures that blend well with the International Maritime Organization (IMO) standard of an international port. The vibrant activity of the port now that must have led to the greater fractal dimension of the area can also be supported by the arduous but well-managed clean up that the Cebu Port Authority with the help of the Australian and American governments in making sure that the international port of Cebu meets the world's standards. Without the black and white scaling or threshoding applied onto the old picture, one sees the haze caused by smog brought about by pollutants in the air that was freely inhaled by people in the area regardless of stature. To confirm it, the researchers checked with the Environmental Management Bureau (EMB) of the Philippines Department of Environment and Natural (DENR) Resources. The bureau disclosed that the Air Quality of Cebu City in 1999 was poor; having averages way above what was considered healthy for humans. Among the noted air pollutants in Cebu City are Total Suspended Particles (TSP), nitrogren dioxide (NOx), sulfur dioxide (SOx), (National Air Quality Status Report, 2002) and volatile organic compounds (VOC).

Original Photographs/Segmented Image



λ = 1.3147 **λ = 1.4112**

Fig.1-Cebu International Port

Table 1. Philippine Emission Inventory, 2001 (tons)

Source: 2002 NATIONAL AIR QUALITY STATUS REPORT,
http://www.emb.gov.ph/portal/Portals/23/PDF%20Files/parttwo.pdf, retrieved 10/13/13

	Area	Stationary	Mobile	Total
PM	226,727	467,102	177,928	871,757
	26%	54%	20%	100%
SOx	16,612	830,100	15,692	862,404
	2%	96%	2%	100%
NOx	2,797,102	517,212	328,800	3,643,114
	77%	14%	9%	100%
CO	1,431,294	113,503	2,512,228	4,057,025
	35%	3%	62%	100%
VOC	148,548	78,764	-	227,312
	65%	35%	0%	100%
TOG	-	-	707,057 100%	707,057 100%

The 2001 Philippine Emission Inventory (Table 1) covers the following air pollutants: particulatematter (PM, also total suspended particulates or TSP), sulfur oxides (SOx), nitrogen oxides (NOx),carbon monoxide (CO), volatile organic compounds (VOC), and total organic gases (TOG, for mobile sources). There is no emission inventory for the criteria pollutants lead and ozone.

Nationwide, a total of 227,312 tons of volatile organic compounds (VOC) were emitted in 2001. Of the total, 65% came from area sources and 35% from stationary sources. The highest VOC occurred in Region 7 (65,224 tons), Region 4 (22,293 tons) and Metro Manila (19,819 tons). The lowest were in Caraga (22 tons), Region 2 (3,596 tons) and Region 9 (5,493 tons). No ARMM figures were available.

Aside from the port, the prominent structure found in the landmark photograph is an international hotel and a shopping mall. The international hotel that provides a breath-taking view of the city and nearby areas is named Radisson Blu which is the first (http://ceburoadtrip.com/radisson-blu-hotel-cebu/,retrieved 10/31/13) of the famous hotel chain in the Asia-Pacific region. It prides itself to have a swimming pool that is 4.8 ft. deep and 800 sq.m. wide, a health club and spa, a gym, and a restaurant that serves Japanese, Mediterranean and other Asian cuisine. It formally opened on Nov. 10, 2010 with Philippine President Simeon Benigno Aquino III in attendance.

Just a few steps from the hotel is a shopping mall known as SM City that was opened in 1993 by business tycoon, Henry Sy. It is located in the North Reclamation Area and lies closely to the boundary of Mandaue City and Cebu City and Cebu International Port. Because of its proximity to the said structures, SM City caters (Villaflor, 2004) to tourists and incidental residents that include travelling businessmen, employees, jobseekers and students. To date, Cebu City has over ten malls that have changed the buying habits and lifestyle of Cebuanos—making malls favored by many as weekend destinations and one-stop shops.

Fig. 2 – Rizal Memorial Library

Inaugurated on Dec. 30, 1939 – Fig. 2 shows the only public library in (Your Complete Guide…,2009, p.144; Cuizon, 2008) the Philippines named after its national hero, Jose Rizal. The oldest if not the only public library in Cebu City, it came from net proceeds of the literary-musical programs and carnival expositions periodically held since 1919 during celebration of Rizal days organized by Cebu's civic – minded residents who were inspired by Rizal's (Cebu Daily News, 30 Dec. 2008)love for education and the youth immortalized in the phrase, "The youth is the hope of the fatherland."

The structure contains books and artifacts about Cebuano history and culture, artworks of Cebuano painters and artists, and antiques belonging to rich and famous Cebuano families at the Rizal Museum and Library. A few years back, the National Library, Order of the Knights of Rizal, and Friends of the Rizal Memorial Library opposed the move of the Cebu City Government to close the Library and convert the whole structure into a museum and then cater to performances and other functions for it to generate funds.

Image segmentation of the picture taken in 1945 and the one taken just recently showed an increase of up to 4.22 percent which means that while the structure has hardly changed. Its ruggedness of form and shape as against the former picture was due to the introduction of electricity as manifested by the posts for powerlines and ornamental plants as part of the beautification project of Osmena Blvd. by the Cebu City government. Shown in Fig. 3 are original photographs of what was formerly known as San Agustin Church, now known by many as the Basilica Minore del Santo Nino. The only Basilica in the Far East, it has a museum that houses religious images and oil paintings of Augustinian saints, martyrs and bishops. The basilica houses the (Your Complete Guide to Cebu's Best Club Cebu, 2nd ed., 2009, p.139) Philippines oldest religious relic – the miraculous image of the Senor Santo Nino.

Compared to the old photo, the latest photograph presents the Basilica with its bell tower in rubbles shortly after a 7.2 magnitude earthquake hit Cebu City and the nearby island of Bohol in the morning of Oct. 15, 2013. Most of the world renowned old churches in Bohol fell to the ground especially that the epicenter of the earthquake was in Sagbayan, a municipality of the province.

As a result, the fractal dimension of the Basilica pictures showed a big variance that reached

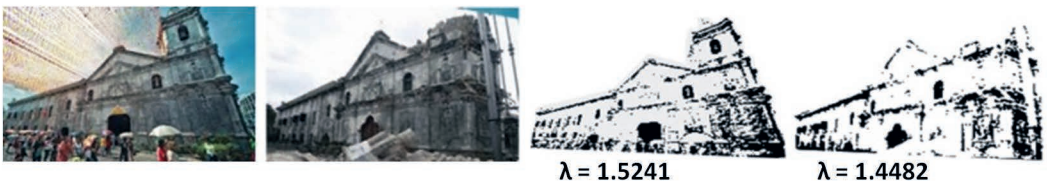


Fig. 3 – Basilica Minoredel Santo Nino

up to -5.24 percent. A still image that tells that while structures may be positively affected by development but it may also be radically affected by acts of nature like an earthquake that has yet to be comprehended fully by man that at times, in the absence of scientific explanation, he considers it an act of God.

Despite being a natural phenomenon not novel in Philippine experience, the latest earthquake that struck Cebu, Bohol and neighboring areas made problems of the past disasters that hit the country recur – ambiguity if not lack of real will to enforce laws like the building code, environmental laws especially on the mandate of Mines and Geosciences Bureau, Phivolcs, including NDRRMC, government's procurement procedures especially in the allocation of calamity funds, corruption and politicking, laws and programs on disaster preparedness as well as relief operations procedures, and awareness of the humanitarian law, as well as the failure of to reach into the people's consciousness the need for information and education campaigns and self-help programs for people to be truly away from harm in times of disasters.

Fig. 4 shows the photographs of the Robinsons Mall situated at the Northeastern side of Fuente Osmena that has become so vibrant with shops, offices, restaurants, and hotels--the latest addition of which is the Crown Regency Hotel and Towers which is presently considered the tallest outside Manila.

Compared to the old photograph taken in April 1999, the new photograph taken in October this year registered a larger fractal dimension of 1.43 percent which can be attributed to the changes in overall structural shape of the area brought about by the addition of the Crown Regency Hotel in 2005 just behind Robinsons Mall.

This area is one favorite area for travelers and business people for hotels and pension houses are abundant here and it is also close to hospitals and key government buildings and historical sites, Thus, it is not surprising to find this area to be a favorite investment area of hoteliers, restaurateurs, and other businesses that cater to tourists or ordinary travelers who are in Cebu for business and leisure.

As proven, trees cushioned the harmful effects

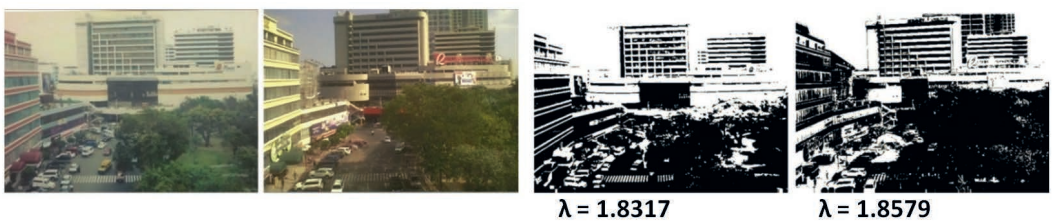


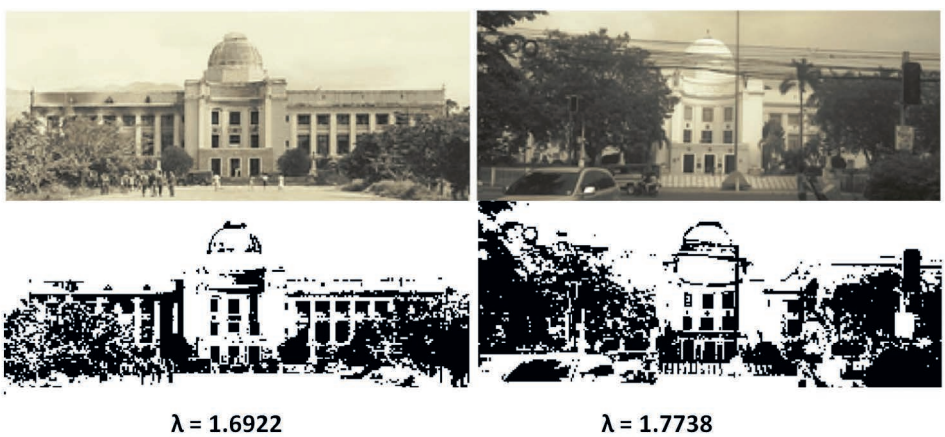
Fig. 4 – Robinsons Mall (Northeast of FuenteOsmeña)

of pollutants either from car and industrial fumes or others from adversely affecting the health of humans. Although, data from Environmental Management Bureau of the DENR reveals a better picture of the air quality in Central Visayas where Cebu City belongs, actual visit of the city will reveal that there is still much to be done for Clean Air Act provisions to be truly beneficial to Cebu City which is the same in the other urban centers in the country.

More on the tallest structure outside of Manila, this fact tells of a great need for a crane or aerial ladders or a helicopter complement of our Bureau of Fire Protection (BFP) so that should this structure be razed by fire, occupants are assured of safety of limbs and life. However, a check on the BFP office here revealed that there is no aerial ladder nor a helicopter that can readily address such concern. Not to mention that the BFP like other government agencies are undermanned and thus one just have to pray not to have fire in this tall buildings nor an earthquake to srike it in his/her presence, or else it will be greatly devastating, life threatening or frustrating at the very least.

Originally a part of the 1912 master plan for Cebu of (http://www.cebu-bluewaters.com/cebu-provincial-capitol.html, retrieved 10/31/13) William Parsons, the Cebu Provincial Capitol that is located at the end of Jones Avenue (now Osmena Boulevard) that resembles America's White House is the seat of the provincial government of Cebu. It was designed by Juan Arellano, a Filipino architect who trained in the United States. Its construction started in 1937 during the incumbency of Governor Sotero Cabahug and was finished one year later during the time of Governor Buenaventura Rodriquez. It was inaugurated on June 14, 1938 by Philippine Commonwealth President Manuel L. Quezon. The governor's office is located at the northern wing while the vice-governor's is located at the opposite wing. The design of the capitol incorporates various styles. For example, the statues that top the pediment of the social hall bear influences of art deco while the columns below it are Tuscan. The capitol was damaged during World War II but was eventually rehabilitated under the Tydings War Damage Act of 1946 (http://www.cebu-bluewaters.com/cebu-provincial-capitol.html, retrieved 10/31/13).

Constructed on February 11, 1912--Fuente Osmena (Fig. 6) stands as a monument to what was considered a modern waterworks system in the early 1900. The first outside Manila, it was built through the efforts of Sergio Osmena who became (Dicatzon, 1999) Governor of Cebu in 1906, and financed by a grant from the American



λ = 1.6922 **λ = 1.7738**

Fig. 5 – Cebu Provincial Capitol

λ = 1.8155 λ = 1.8763

Fig. 6 – Fuente Osmeña Circle

Government, It involved the construction of a dam in Buhisan mountain to serve as a reservoir for the water system and then piping the water all the way to the city – about 21 kilometers. It was inaugurated by then Cebu Governor Dionosio Jakosalem and American Governor General William Cameron Forbes.

The difference of fractal dimensions of the old (1999) and new (2013) photos of Fuente Osmena Circle registered an increase of up to 3.35 percent which can be attributed to the thicker foliage and more evident growth of trees now that have enveloped the circle making the majestic water fountain almost invisible from the cameraperson's point of view.

This phenomenon can be due to the increased awareness of the local officials, academe and the private sector to improve the air quality of the Cebu City by planting trees and intensify its beautification and cleanliness drive and a more

Table 2. Summary of Fractal Dimensions of Old and New Binary Image

Location	Fractal Dimension		Change of Fractal Dimension	Major Reason for Fractal Changes
	Old	New		
Cebu International Port	**1.3147**	**1.4112**	**7.34 %**	Compliance of IMO standard.
Robinsons Mall	**1.8317**	**1.8579**	**1.43 %**	Construction of new Building (Crown Regency Hotel).
Basilica Minore del Sto. Niño	**1.5241**	**1.4482**	**-5.24 %**	Natural Calamity (Earthquake).
Rizal Memorial Library	**1.7019**	**1.7738**	**4.22 %**	Renovation of the Building.
Cebu Provincial Capitol	**1.6922**	**1.7738**	**4.82%**	Renovation, electrical wires and poles.
FuenteOsmeña Circle	**1.8155**	**1.8763**	**3.35%**	Growth of Trees.

serious enforcement of laws. Being a structure that reminds citizens of the great leader, Fuente Osmena is also catching so much attention and care from Osmena's descendants and followers in Cebu, so that when re-elected Mayor Michael Rama two years back proposed to renovate the area, his move was met with so much criticism (Felicitas & Adlawan, Nov. 20, 2011) from his opponents in the Cebu City council, living descendants and followers of Sergio Osmeña.

4.0 Conclusion

The results of multifractal analysis using the image segmentation through thresholding, Otsu's method, and comparative tempo-spatial pattern analysis method can be validated by supporting pieces of evidence surrounding the structure or landmark under study. The fractal dimension provides a quantitative measure on the space filling property of the image.

While the fractality is translated in figures, such can be translated further into more meaningful terms by the documents and testimonial evidence that prove the logical basis of the fractal dimensions which ordinary individuals will understand and eventually appreciate the benefits of fractal geometry.

As economic development advances to the outlying areas of the urban center, some benefits and tradeoffs also come with it. This holds true in Cebu City. Aside from the technical and dimensional explanation, the difference between the fractal dimension of the old and the new pictures may be attributed to a number of factors such as environmental change, local development agenda and legislative clarity.

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