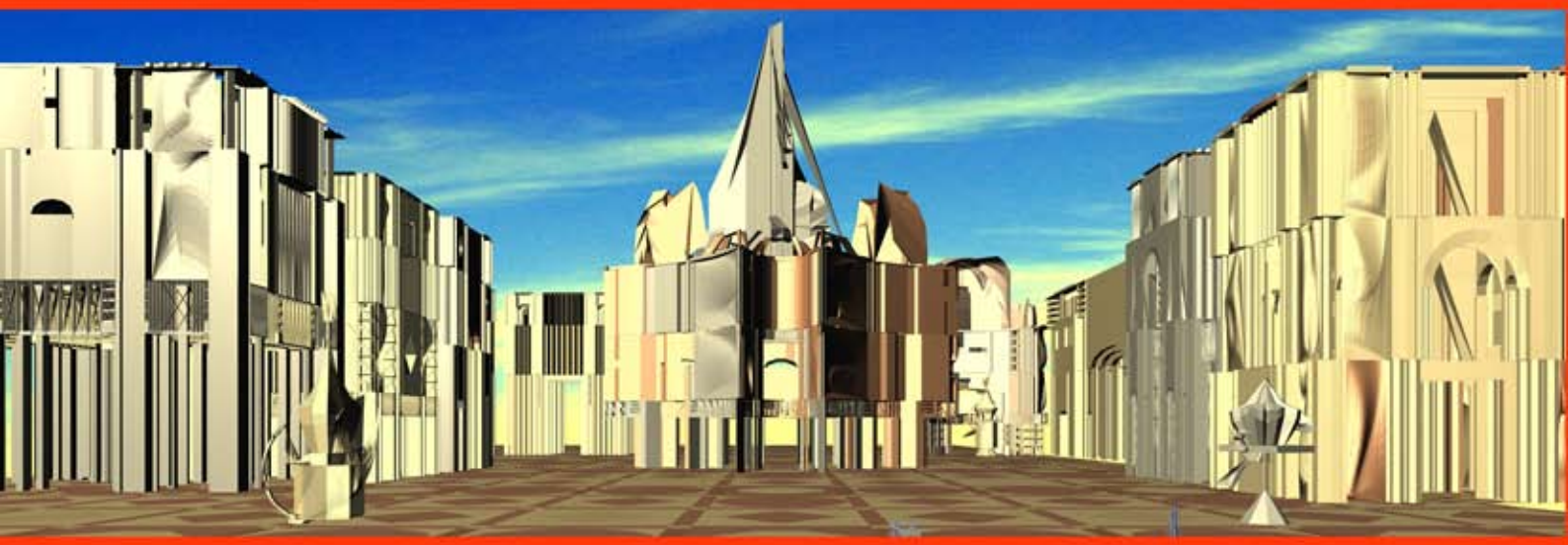
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8th Generative Art conference

edited by
Celestino Soddu



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In the 1st cover a visionary variation of "Citta' Ideale", generated using the codes of harmony of Renaissance, 2005.
In the 2nd cover a visionary variation of "Citta' Ideale" using generated coffee machines, 2003.
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Index

Papers

Celestino Soddu
Generative Design Lab, Politecnico di Milano University, Italy
Gencities in a Visionary World
Pag.11

Alain Lioret
Arts et Technologies de l'Image. Universite' Paris 8, France
Past images of the future
Pag.25

Paul P. Brown
Angila Polytechnic University, Cambridge, UK
"Psst.....Wanna Buy an Algorithm? The Proliferation of Generative Music Systems throughout Everyday Life and its Affects on the Music Industry"
Pag.35

Alcinia Zita Sampaio, Pedro Gameiro Henriques, Pedro Studer Ferreira, Rui Pedro Luizi
Technical University of Lisbon, Portugal
Using 3d virtual models in civil engineering training: interacting with the construction processes
Pag.46

Belinda Torus
Yýldýz Technical University, Istanbul , Turkey
Generative Design in Architecture and Mass Customization
Pag.55

Bogdan Soban
Artist, Slovenia
Generating Artwork Using Previous Created Image as Coloring Palette
Pag.67

Carol-Ann Braun
Le Cube, France
Generative Art in the Public Eye
Pag.74

Chiron Mottram
Bartlett School of Graduate Studies, University College London, UK
Agent Visualization
Pag.82

Daichi Ando, Hitoshi Iba
The University of Tokyo, Japan
Real-time Musical Interaction between Musician and Multi-agent System.
Pag.93

David Psenicka
University of Illinois, US
Composing Music Based on Interaction with Self-Similar, Symbolic Tree Structures
Pag.101

Paul Coates, Christian Derix, Ing. Stefan Paul Krakhofer, AbdulMajid Karanouh
CECA UEL MSc Computing & Design, UK
Generating architectural spatial configurations. Two approaches using Voronoi tessellations and particle systems.
Pag.110

Elyna Amir Sharji
Multimedia University, Malaysia
Electronic Gallery as a Generative Space for the Contribution to Art and Design Students and the Learning Environment
Pag.128

Francesca Bertacchini, Caterina Senatore, Adriano Talarico
Universita' della Calabria, Italy
Plexus: a story telling system based on the small world networks model
Pag.139

Gülen Cagdas, Gaye Gozubuyuk, Özgür Ediz
Istambul Tech University
Turkey
Fractal based genereative design for harmony between old and new
Pag.150

Hengfeng Zuo, Mark Jones
Southampton Solent University, UK
Exploration into form aesthetics of design: material texture
Pag.160

James Basson
Societe Scape SARL, France
the garden
Pag.172

K. Moraes Zarzar
TUDelft, The Netherlands
Design Precedents and Identity: the exercises
Pag.184

Kenneth Hansen
Roskilde University, Denmark
Otopia
Pag.196

Manuel Beaz
Carleton University, School of Architecture,Canada
The Generative Dynamics of X, Y & Z Coordination
Pag.217

Marie-Pascale Corcuff
ècole d'architecture de Bretagne, Universite' Rennes 2, France
Generative processes and the question of space
Pag.226

Mark Rudolph
IT-University Copenhagen, Denmark
MetaForms Methodology for specifying and growing Structures of Forms for Aesthetic and Programming Content
Pag.241

Matteo Melioli
Bartlett Design Research Department (UCL), UK
Inhabit soundscape, The Architecture of the Invisible World
Pag.250

Mauro Francaviglia, Michael Petry, Marcella Lorenzi
Universita' di Torino, The Museum of Contemporary Arts, London, Italy, UK
superstring installation
Pag.265

Michela Turrin
Architect, Italy
Digital shapes: contextual and semiotical legibility
Pag.277

Nelly Bogdanova
Daugavpils University, Latvia
Creating tiling by means of 2D graphics applications
Pag.287

Nicolas Reeves
Hexagram Institute for Research and Creation in Media Arts and Technology, Canada
[VOILES | SAILS] - Self-Assembling Intelligent Lighter-than-air Structures
Pag.297

Nicoletta Sala
Universita' della Svizzera italiana, Swiss
Fractal components in the Gothic and in the Baroque Architecture
Pag.316

Nyssim Lefford
Sonic Studio, Acusticum 4, 941 28 Piteå, Sweden
Investigating Composers' Perceptions and Style through Musical Composition Games
Pag.323

Mahnaz Shah
Architectural Association, School of Architecture, London , UK
The Modular: An Analysis into Generative Architecture
Pag.333

P. Coatesl, C. Derix , T. Lau,
CECA UEL MSc Computing & Design, UK
Topological Approximations for Spatial Representations
Pag.351

Peter Beyls
Hogeschool Gent & University of Plymouth UK, Belgium
A molecular collision model of musical interaction
Pag.374

Philip Van Loocke, Yannick Joye
Gent University, Belgium
Complex constructions based on symmetry breaking in simple three dimensional IFS. 'Description of interface between Visual Basic and Microstation'
Pag.386

Pi-Yuan Tang
National Chiao Tung University, Taiwan
Co-generation 3D Form: The Framework of Co-generative Design System
Pag.394

Ricardo Gomes
San Francisco State University, US
Designing to Live: The Value of Inclusive Design in the Future Society
Pag.400

Fabian Scheurer, Christoph Schindler Markus Braach
ETH Zürich, Chair of CAAD, Swiss
Three complex structures built with a digital production chain
Pag.403

Semra Arslan Selcuk, Al J Fisher, Chris JK Williams
Middle East Technical University, Turkey
Biomimesis and the geometric definition of shell structures in architecture
Pag.413

Tian Yunqing, Bao Lin
Shanghai University, China
The Reconstruction of the Center Square of Chang Shou Park - A Practical Case of Generative Design
Pag.423

Tom Davis, Pedro Rebelo
Sonic Arts Research Centre, Queens University Belfast, Northern Ireland
Natural Selection: A Stethoscopic Amphibious Sound Installation
Pag.427

Nicola Dioguardi
Humanitas, Milano, Italy
The physical side of liver diseases. Measuring irregular bodies: a need for medical disciplines
Pag.435

Andrea Wollensak, Brett Terry
Connecticut CollegeUS
Transitory Spaces
Pag.445

Karel Dudesek
Ravensbourne College of Design and Communication , UK
The process of creation. Student projects of the postgraduate courses in Ravensbourne, contextualized in applied art and critical practise, or how to avoid reinventing the wheel again and again in art and design.
Pag.453

Melanitis Yiannis
performance artist, Greece
Biological dynamics in performance space
460

Aleksandra Slahova, Maris Cacka, Ilze Volonte, Alnis Stakle, Baiba Valpetere, Zeltite Barsevska, Jolanta Savvina, Ilze Meldere, Mairita Folkmane, Agita Aleksandrovica
Daugavpils University, Latvia
The Characteristic of Professional Higher Education Bachelor Study Programme "Computer Design" in Daugavpils University
Pag.478

Mario Costa
Universita' di Salerno, Italy
Nature as source of Generative Art
Pag.484

Umberto Roncoroni
Faculty of Communication Sciences, Universidad de Lima, Perú
Emergence, Beauty, Software and Kitsch
Pag.487

Yehuda E Safran
Columbia University, US
Mimetic desire and other Symptoms
Pag.498

Enrica Colabella
Generative Design Lab, Politecnico di Milano University, Italy
Out of Hours
Pag.503

Posters / Installations / Artworks / Performances

Enrica Colabella, Josette Martial, Celestino Soddu
Rome, Milan, Italy
Out of hours
2nd part. Pag.1

Carla Farsi
University of Colorado at Boulder, US
Difference Equations
2nd part. Pag. 3

Matjuska Teja Krasek
artist Slovenia
Kaleidoscopic fragrances
2nd part. Pag.5

Roberto Iengo, Stefano Fantoni, Nico Pitrelli
Interdisciplinary Laboratory SISSA, Trieste, Italy
Images and impressions on frontiers of physics
2nd part. Pag.11

Semi Ryu, Claudio Scozzafava, Stefano Faralli
School of the Arts, Virginia Commonwealth University, US
Universita' di Roma La Sapienza, Italy
Infinite Cemetery: Virtual Reality + Generative Sound
2nd part. Pag.15

Tatsuo Unemi, Daniel Bisig
Soka University / University of Zurich, Japan, Swiss
Flocking Orchestra
2nd part. Pag.19

Martin Franklin, Lee Adams
UK
Bindu Point
2nd part. Pag.22

Artemis Moroni
D. Robótica e Visão Computacional, CenPRA, Brazil
arTbitrating: an evolutionary environment for visual and sound composition
2nd part. Pag.25

Robert Seidel
Bauhaus University Weimar, Germany
_grau
2nd part. Pag.29

Daniel Wilson, Sebastian Gassner
Goteborg University and Chalmers University of Technology, Sweden
A Study in Synchresis
2nd part. Pag.31

Luca Tanzini
Universita' di Siena, Italy
LESA
2nd part. Pag.34

Martha Gelarden
Moore College of Art and Design, Philadelphia , US
New Orleans
2nd part. Pag.37

Roc Jimenez de Cisneros Baneg
Barcelona, Spain
Evol, Punani Series Live
2nd part. Pag.40

Pierre Proske
IT University Goteborg, Sweden
Synchronized Swamp: Uncanny Expressive Mathematics
2nd part. Pag.41

Emilio Musso
Faculty of Science, L'Aquila, Italy
Density flow of a vector field along the roman surface of Steiner
2nd part. Pag.48

Davide Morelli, V. Ianitto
Italy
Orme.04 a jam session featuring a computer as an improvising musician
2nd part. Pag.52

Assunta Tavernise, Adolfo Adamo
University of Calabria, Italy
Generation of Ego dynamics
2nd part. Pag.53

FRACTAL BASED GENERATIVE DESIGN FOR HARMONY BETWEEN OLD AND NEW

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Abstract

In this paper, a computational design model based on the fractal dimension will be presented. Fractal dimension is used as a means of capturing the pattern appropriate at the compositional configuration of a historical architectural language and generating new forms, which will ensure the continuity of this language. In the first stage, architectural characteristics of a district with special architecture will be defined by calculating fractal dimensions in different levels. In the second stage of the model, this fractal values are used as input in computer program for producing form alternatives for the new buildings that will be designed in such places. This two-staged model, which is generated for the purpose of providing harmony between new and old, is applied to Chora, which is an important historical settlement of Istanbul. The generation process describes how to derive a compositional configuration from other forms with different dimensions, which can be generated by changing fractal dimensions.

1. Introduction

Computer supported design systems can generate different images during the early design process and provide useful inputs when searching for alternative forms of architectural design products. It is aimed that the generative approach which is used in this study will be used for supporting the creativity to produce architectural forms based on an existing architectural pattern. Providing harmony in architectural design between old and new is a great problem for cities like Istanbul, which are growing around historical core. New buildings must be both unique and conformed to the proportional feature of the old buildings. In this way the proportional characteristic of

original pattern of a historical environment or of a special environment is protected. In the development of this approach, the following stages have been carried out:

Calculating the fractal dimensions of a historical city part for defining the architectural characteristic.

Using a computer model for generating form alternatives according to the fractal values [1].

Testing these form alternatives in the 3D model of this historical city part.

2. Fractal Geometry and Architecture

Geometry is the fundamental of the architectural discipline. It is a tool for describing thoughts of a designer for creating architectural product itself and its two and tree dimensional representations; drawings and models. For the purpose of creating architectural objects Euclid geometry has been used for ages. According to Bovill the reason of the influences of Euclid geometry being so strong in architecture is that architectural forms are man-made [2]. The researchers describe the relationship between Euclid geometry and architecture with the effects of mass-production in architectural design because the forms of building elements, which are produced with mass- production depends on Euclid geometry [3].

On the other hand the architectural design approaches based on nature revealed the effects of fractal geometry in architecture. Fractals - which were introduced by Benoit Mandelbrot in 1980s for describing the forms of natural objects, like coasts, mountains – have appeared in architecture with the details from a larger scale to the smaller one [4].

Although there are many examples, which based on fractal concept in the history of European, African, Asian and American architecture fractal geometry is begun to be used consciously in architecture with the new design approach in computational architectural design. Fractals could be represented by generative algorithms in computer with their major characteristics; developing through iterations, depending on starting conditions. In this way they could be used for designing forms, structures and surfaces alternatives [2].

In this study, fractal dimension is used as a means of capturing the pattern appropriate at the compositional configuration of a historical language and generating new forms, which will ensure the continuity of this language:

The aims of this study are:

To support the creativity of designers in early design phases;

To generate and give a preliminary ranking to the form alternatives

3. Case study

In the case study, fractal dimension is used in two ways. Firstly it is used for determining fractal characteristic of a historical district in Istanbul and secondly it is used within a computer model for creating new buildings forms, which have the same fractal characteristic with this place for providing the harmony between old and new. For the case study, Chora (Kariye) district has been chosen.

Chora

The Kariye neighbourhood is located in the district Edirnekapi in Istanbul. The word Kariye (Chora) meaning "outside of the city", or "rural" is derived from old Greek [5].

In Kariye there are many monuments of the Byzantine and Ottoman periods. Kariye Church (Figure 1), Tekfur Palace (Figure 2), and Kastoria synagogue are some of these monuments.







Figure 9.Chora church [6

Figure 2. Tekfur Palace [7]

Chora Church, the symbol of the district is built on the site of a chapel, which is located outside of the city walls, by Justinianus. Several additions and repairs, which were made between the years 1315 – 1320, formed the current shape of the building. The mosaics and frescoes examples in Kariye Church are regarded as the most beautiful of the last period of Byzantine art. In the surroundings of the church, traditional Ottoman houses and streets are located. (Figure 3)



■	The buildings of which fractal dimension is calculated
■	The building in the place of which alternatives are generated
□	The buildings in the neighbourhood of the field study
□	Historical buildings in the neighbourhood of the field study

Figure 3. Site plan of the Kariye Bostani Street

3.1. Kariye Bostani Street

The reason why this place is chosen for field study is the traditional architectural pattern of the street. There are both the examples of multi-storey buildings, which were built after 1950's and of low storey buildings of traditional Ottoman Architecture near the street. Although the pattern of the street is protected in a large scale, the effects of chaotic architecture of the environment can be seen on the street.

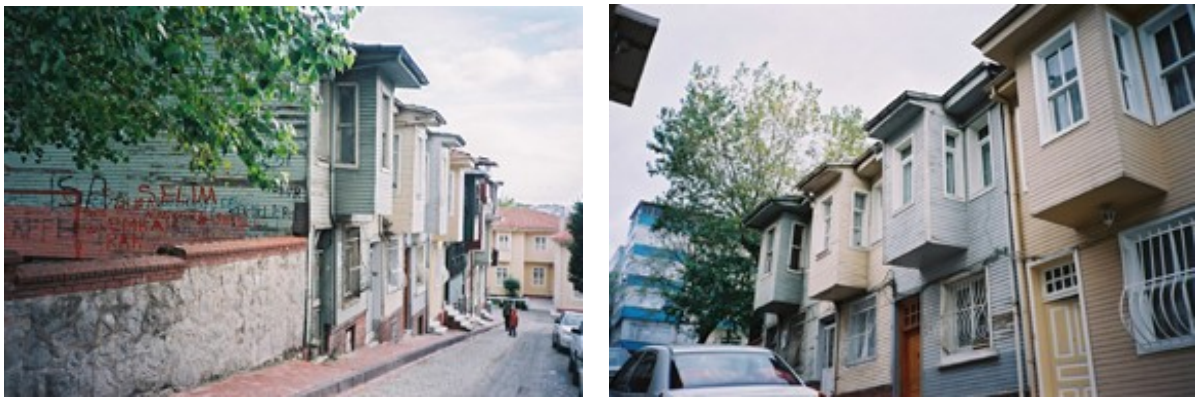


Figure 4. The Protected side's of the street



Figure 5. The Protected side's Silhouette of the street

On the both side of the Kariye Bostani Street traditional Ottoman houses are located. (Figure 4, 5, 6) All the houses on the one side of the street are two or three storied wooden row houses and have a bow - window (cumba) on each façade. (Figure 4, 5) On the other hand there are five or more storied concrete buildings, which are not in a harmony with these buildings, on the other side of the street. (Figure 7, 8)





Figure 6. The other side of the street



Figure 7. The other side's Silhouette of the street

In this study, a design model is suggested for providing proportional harmony between the forms of traditional buildings and new buildings and for protecting the street pattern.

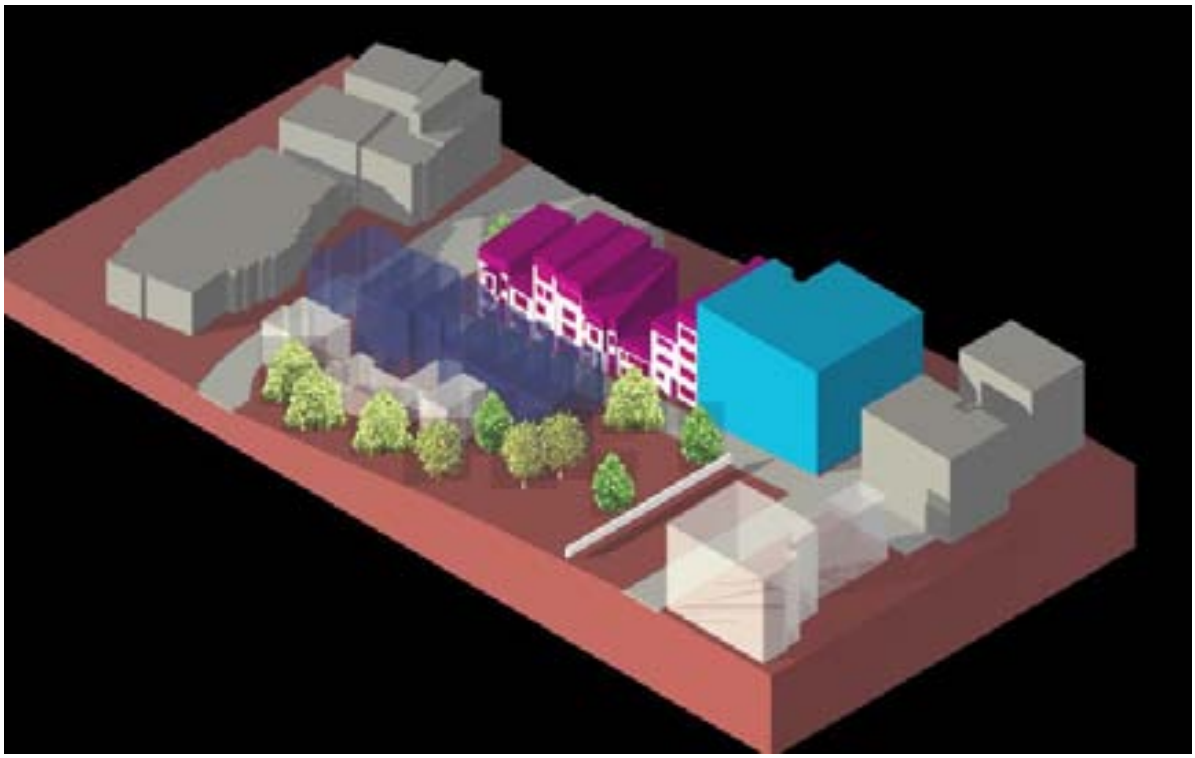


Figure 8. 3D model of the current situation of the Kariye Bostani Street

4. Generating new form alternatives in Kariye Bostani Street

In the generation process of new form alternatives a computer model has been used [8, 9]. The model starts with the analyses about the Kariye Bostani Street. Fractal dimension takes the most important role in the analyzing level. For defining characteristic features of the architectural language of the Kariye Bostani Street, fractal dimensions in plan, silhouette and building scale have been calculated [10]. The fractal values obtained by using Bovill's Box-counting method have been used as inputs in the computer program for composing alternative forms on the selected place in the street. (Figure 9)

With the aim of creating new forms according to the fractal values of the existing pattern, the place of the corner building which does not suit with the architectural characteristic of the Kariye Bostani Street is chosen for the project area. (Figure 7, 8 building with colour blue) The new form alternatives are generated in the 18mx18m square shaped project area by defining the number and dimensions of initial shapes on x-y and z axis. Therefore a grid system of boxes was superimposed over the project area on x-y axis [11]. In this way, dimensions of the initial shape have been defined.

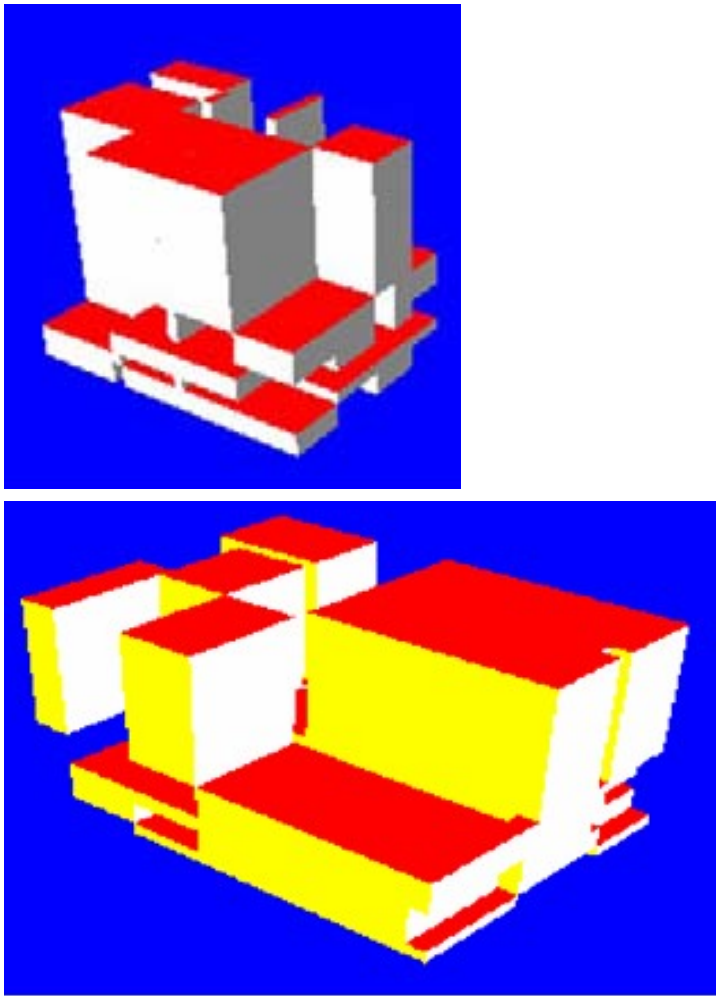


Figure 9. Form alternatives

In the next stage of the generation process two different initial shapes, a 3mx3mx3m cube and a as 3.60mx3.60mx3m square prism have been used for obtaining various design alternatives. In the last stage, fractal dimensions - which are calculated as 1.7 in the settlement scale and 1.2 both in the silhouette scale and building scale - have been applied to the initial shape for generating new forms. Finally, these generated form alternatives were tested on the 3D models of the Kariye Bostani Street and its surroundings, which were created in virtual environment. (In the first three alternatives, a 3mx3mx3m cube and in the fourth and fifth alternatives a 3.60mx3.60mx3m square prism has been used as initial shape.)

4.1 Form Alternatives

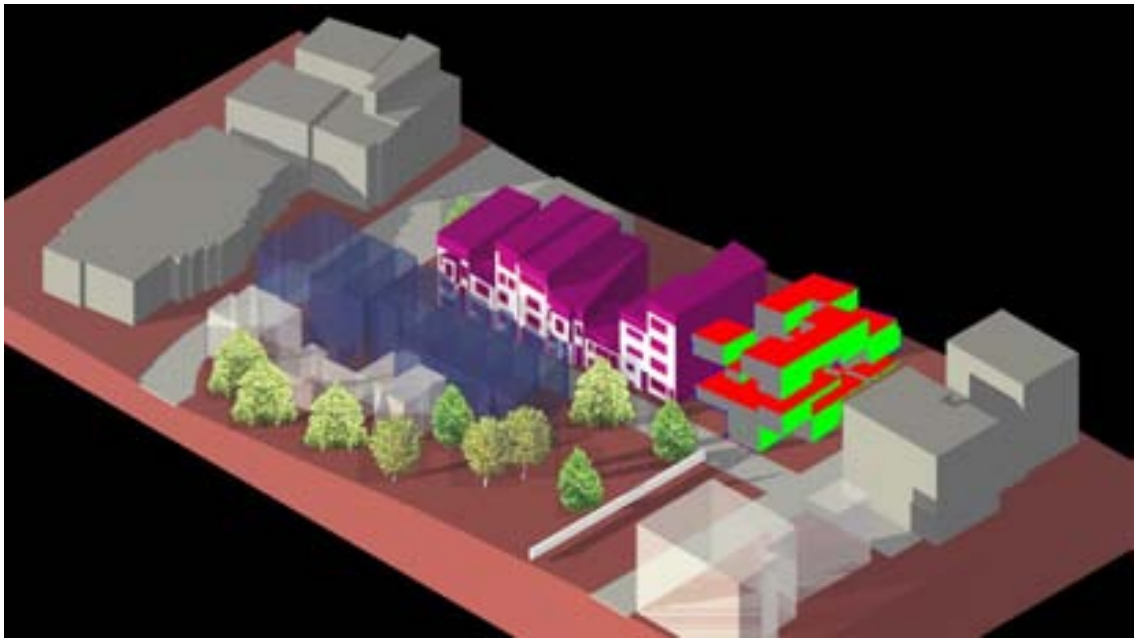


Figure 10. Alternative 1

Table 1. Fractal values and the number of cubical units on x, y, z-axis, which have been used in

Alternative 1

Fractal dimension	Cubical units on the x- axis	Cubical units on the y- axis	Cubical units on the z- axis
1.7	6	6	4

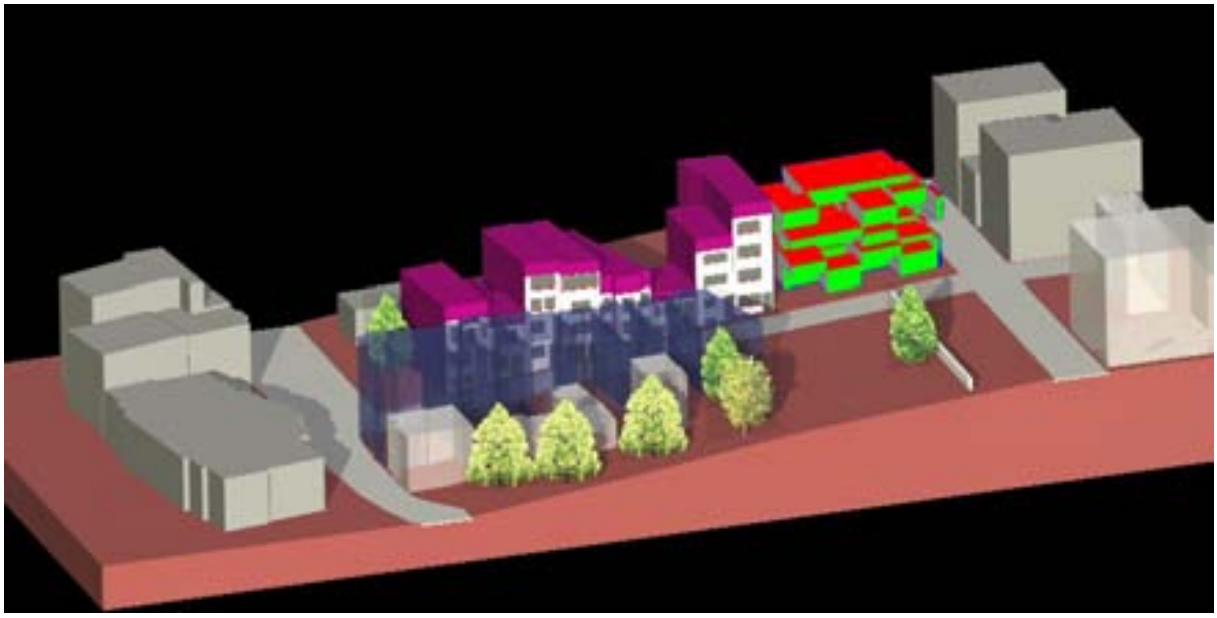


Figure 11. Alternative 2

Table 2. Fractal values and the number of cubical units on x, y, z-axis which have been used in Alternative 2

Fractal dimension	Cubical units on the x- axis	Cubical units on the x- axis	Cubical units on the x- axis
1.7	6	6	5

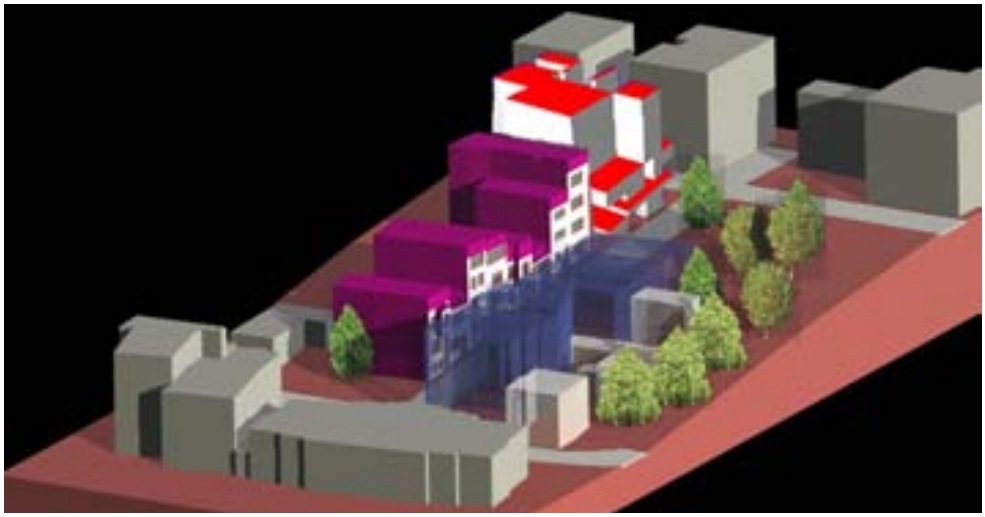


Figure 12. Alternative 3

Table 3. Fractal values and the number of cubical units on x, y, z-axis which have been used in Alternative 3

Fractal dimension	Cubical units on the x- axis	Cubical units on the x- axis	Cubical units on the x- axis
1.2	6	6	5

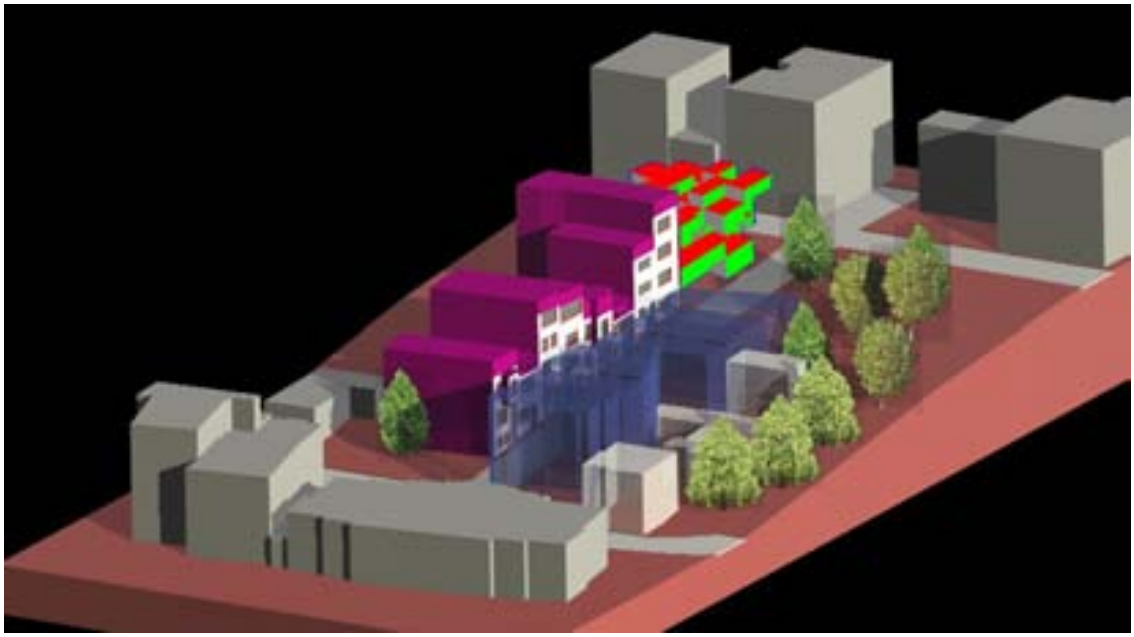


Figure 13. Alternative 4

Table 4. Fractal values and the number of box units on x, y, z axis which have been used in Alternative 4

Fractal dimension	Box units on the x-axis	Box units on the y- axis	Box units on the z- axis
1.7	5	5	5

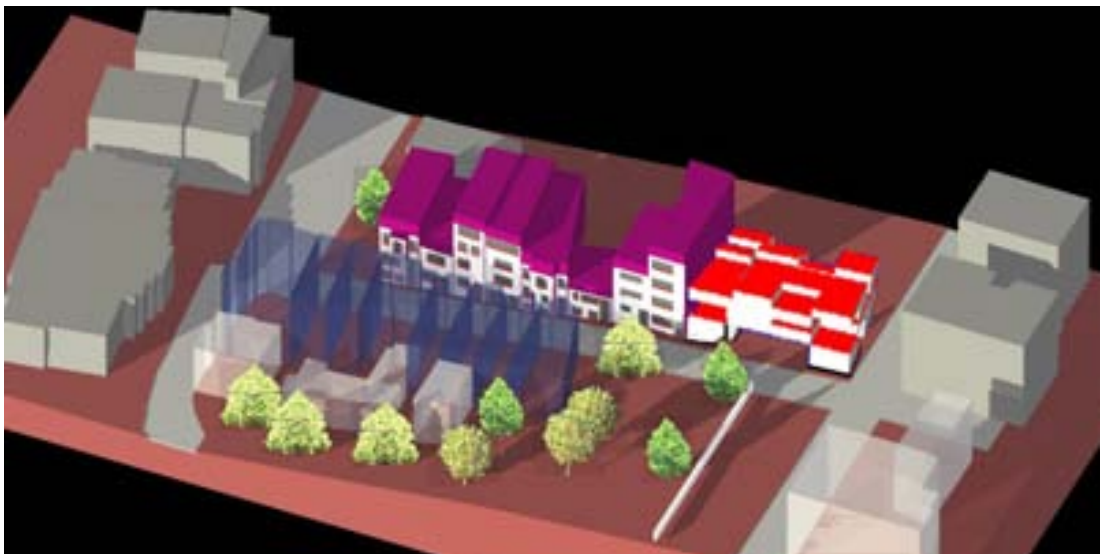


Figure 14. Alternative 5

Table 5. Fractal values and the number of box units on x, y, z-axis which have been used in Alternative 5

Fractal dimension	Box units on the x-axis	Box units on the y axis	Box units on the z- axis
1.7	5	5	5

5. Conclusion

One of the significant problems in architectural design is providing harmony between old and new. Fractal concepts have been come to use in many ways, both consciously and unconsciously, in the field of architecture.

In this study, by relying on the fractal dimensions of an existing architectural pattern a generative design approach has been suggested which can be used in the process of supporting creativity in the creation of new forms and for testing harmony between old and new .By using the fractal dimensions of elements found in a shape library belonging to the relevant architectural language, this approach may show the way to the creation of architectural forms which will ensure the continuity of the pattern.

Using digital technologies while searching for alternative forms in the conceptual design phase is a new approach based on the development of new technologies. Using digital media as design media gives the designer the opportunity to expand his/her imagination and innovations.

By placing the three dimensional form alternatives in the settlement model, harmony has been tested with the existing architectural language.

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