A Generative Design Model for Gaziantep’s Traditional Pattern

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Abstract. This paper describes a research to develop new urban design alternatives for Gaziantep by using fractal based approaches. The aim of the research is not only generating new form alternatives but also considering the continuity of traditional architectural and urban pattern which faces deterioration. Within this study, it is intended to test the applicability of the fractal based generative approaches and explore the potential advantages. The method called CADaFED (Ediz, 2003) is updated to be used in one of the 3d modeling programs, 3DsMax scripting and it is used as an experimental tool in two-day student workshop. The working field is limited as Bey Neighbourhood in Gaziantep for its well-preserved architectural characteristics. In this paper, the outcomes of the student workshop will be evaluated and discussed in the sense of affirmative effects of fractal based design approaches.

Keywords. Generative design; fractal based design; computational architectural design; traditional pattern.

Introduction

The role of computation in architectural design has been discussed for more than three decades. Using computation as a media in design field, rather than a tool opens up new design and manufacturing approaches. The development of new computational design approaches offer possibility of rethinking the design process.

Today most of the designers start design activity with traditional methods and afterwards use computers as digitalizing and visualizing tool. While the general tendency is modifying traditional techniques to benefit from digital technology and using computer as a tool, with the development of new generative design approaches, we start to deal computer as a parallel thinking system. New design approaches brought together new design processes, practices and though new visualization techniques, production technologies.

Computer aided design approaches provide new ways of thinking besides/beyond providing a layout for form generation. Therefore, the computers allow not only presentation and visualization but also support the enrichment of the design process itself through computation. Shape grammars, rule based design, parametric design can be considered as precursor generative design approaches. Shape
grammars are used for creating new forms that are 
feed by an existing architectural language. First ex-
amples of shape grammar started in 80’s with manu-
ally produced model, developed day to day and 
reached to models which are totally produced with 
computers. The Prairie Houses of F. L. Wright (Konig 
and Eizenberg, 1981), Traditional Turkish Houses 
(Çağdaş, 1996), Marrakesh Patio Houses (Duarte et 
al., 2006) are some shape grammar examples that 
motivated this research. However, in this paper we 
focus on fractals which defined as a subset of shape 
grammars by Schmitt and Chen (1991). This is be-
cause, we suppose that fractals have a potential of 
enriching the designers’ way of thinking in the field 
of computational architectural design.

In order to explore the potentials of the fractal 
based generative approaches, an updated version of 
CADeFED (Ediz, 2003) is used as a form generation 
tool and Gaziantep is selected as a working field, 
conducted with a two-day student workshop. The 
outcomes of the student workshop will be evaluated 
in the discussion part.

Gaziantep as a Case Study Field

In this project, Gaziantep was chosen as a case study 
field. By analyzing Bey Neighbourhood which is the 
best example of Gaziantep traditional city pattern, a 
generative housing design model is proposed. The 
ultimate goals of this project are; deriving the contin-
uity of traditional pattern, adapting existing pattern 
to new living and city circumstances, concurrently 
finding architectural solutions for new demands. It 
is targeted to use fractals in architectural design able 
to generate novel urban and housing configurations, 
while respecting certain cultural and spatial aspects, 
as captured by the shape grammar.

Situated in the south-eastern region of Turkey 
(Figure 1), Gaziantep is a very picturesque city. Old 
city of Gaziantep has narrow streets, carved stone 
walls and jarkin head roofs (Figure 2 and Figure 
3). Gaziantep houses are structures which faces 
the courtyard behind high walls and as abstract as 
possible from the outer world [1]. They are generally 
two storey buildings; service rooms like bathroom, 
kitchens are placed in the basement floor and living 
rooms are in the upper floors. External circulation for 
higher storeys and the courtyards which are used 
frequently during summer with the effects of terres-
trial climate are some other characteristic features 
of Gaziantep old style houses. Generally buildings 
are constructed on a top of a cellar carved into the 
bedrock. Since the wooden sources are limited in the 
region, soft limestone, round mass stone, hard lime-
stone, minaret rock, basalt (black stone), marbles 
and some kind of coloured stones gathered from na-
ture were used. One of the strong features of these 
stones is they keep dwellings cool in summer and 
hot in winter.

Like population growth, migration, climatic con-
ditions and economics so many forces and interre-
lated systems play an effective role in the develop-
ment of cities. To understand the process of devel-
opment which has a dynamic structure we should 
consider all parameters simultaneously. Parametric 
design methods provide an appropriate logic to pur-
sue the process of development and make sugges-
tions. All architectural structures which originate the 
morphology of cities are the ingredients of a whole. 
When we analyze these morphologies we can see 
differences due to economical, environmental and 
climatic conditions. Today, these different character-
istics melt in a pot and all dwellings seem like each 
other.

There is a similar problem in Gaziantep; tradi-
tional houses have been damaged by means of lack 
of care over time and constructing new storeys onto 
them. In 1950’s, by moving of inhabitants to apart-
ments, Bey Neighbourhood was starting to get em-
pty and abandoned. Due to these reasons traditional 
patterns are getting lost day by day and it gets harder 
to see the characteristics of old houses in new settle-
ments. In this project the suggested design model 
is created for defining the compositional character-
istics of the local architectures and generating new 
forms, which suit to the characteristic of the pattern
for ensuring the continuity of the architectural language. Gaziantep, Bey Neighbourhood, which is the best example of civil architecture, is selected as a key study area for adapting traditional characteristics to changing conditions of life and also to find adaptable and innovative architectural solutions for this district.

Generative algorithms can be used for creating new form alternatives in the area of computational architectural design. In this paper, a three staged design model based on the fractal approach is developed for generating new forms in the settlements, which have a special local architectural language. It is aimed to produce new buildings for deriving the formal characteristics of the architectural pattern.

**Case Study: Implication and Methodology**

A student workshop was organized in Istanbul Technical University, between 30th March and 13rd April of 2010. 16 master students of Architectural Design Computing Graduate Program participated in two-day workshop. They worked as groups or either individually.

The workshop includes the introduction of the methodology phase, secondly form generation process by students and afterwards evaluation of the generated models. After a brief presentation of Gaziantep, students were expected to calculate various fractal dimensions of selected area. By using these calculated dimensions they were expected to study on computationally generated forms. Afterwards the generated models located and adapted to the working site.

The mediums which are used during the student workshop are listed below (see Figure 4):

- ImageJ (for fractal dimension and lacunarity calculation),
- CADaFED (only algorithm of the CADaFED is used and updated),
- 3DsMAX (CADaFED converted to 3DSMax via maxscripting).
Figure 4
The flow chart.

Figure 5
Left: The layout plan of Bey Neighbourhood. Right: Working fields.
First Day of the Student Workshop

First, the students started to calculate various fractal dimensions from the 1:1000 scaled layout plan of Bey Neighbourhood, in ImageJ software (Figure 5). The image of layout plan is imported in *jpeg format into ImageJ. The imported image is converted to binary format. After this, the fractal dimension is calculated based on box calculation.
method in the same software. The software provides a set of numbers between 1 and 2 as a fractal dimension value.

In the second phase the fractal based tool, the plug-in which has been developed by 3DsMax scripting is used in 3D modeling environment was used. The algorithm of the plug-in requires four parameters. The first parameter represents the fractal value that has been calculated before (in this study it has been calculated by ImageJ, however other interfaces such as Harfa also could be used). The students have been warned about the typing style of the fractal dimension that the typed numeric value corresponds the decimal value of the fractal dimension after the number ‘1’. For example, 2 represents 1.2 in the plug in algorithm.

The second, third and forth parameters are related to the unit numbers in X, Y, Z axes. Thus, X and Y, the width and the length of the form refer to the number of the spaces in facades of the form. On the other hand the last parameter, Z is related to the number of floors. In this study the floor height is assumed as 3.5 meters. After typing the four parameters, the program generates different form alternatives. Depending on the four parameters and the sense of fractals, the algorithm of the plug-in still has a degree of randomness.

Because of the limitation of the program, the generated forms require three adaptations. These adaptations can be listed as:
- Location adaptation,
- Scale adaptation,
- Rotation adaptation.

The adaptations were done manually by the students according to the basic needs of the given area. Some of the examples are shown below. Values; *1-1-1-1 written on the images mean in order;
fractal dimension (program gives dimension as 0.X, we used x value), and x,y,z coordinate values.

Second Day of the Student Workshop
In the second day of the workshop another concept, lacunarity was briefly introduced to the participants. The task of the second day included three steps: lacunarity calculation of the existing condition; adaptation of previously generated forms into the site; recalculation of the lacunarity value and the comparison.

The lacunarity values were expected to be calculated for the given front views. ImageJ software was used for lacunarity value calculations based on a similar way in the first day of the workshop:
- Importing the facade view in jpg format,
- Converting into binary format,
- Calculating the lacunarity value.

After this step, the students added their previously generated forms into front view of the selected areas. They used either 3DsMax environment for basic renderings or one of the other drawing software packages. Following the adaptation step of the computationally generated forms, they calculated the lacunarity value again.
Discussion

The research described in this paper aims to reveal the potentials of fractals as a conducive tool to develop alternative design solutions for early stages of architectural design and some kind of urban design problems. The paper focused on the use of fractals as a tool during a workshop and evaluating consequences of the productions in the sense of architectural design, urban design and design education.

There are lots of different features of fractal based models. In this study, we tried to handle affirmative and conducive effects of the model through two-day student workshop. As far as this fractal based tool produced abstract models for early architectural design phase and also alternatives for infill projects in urban scale, most of them are available and applicable to be improved and to be designed more detailed. Also they are appropriate for the continuity of the traditional pattern in the sense of scale, emptiness-fullness and urban configuration.

Another feature which should be handled is speed and quantity of the production. With this method, design alternatives are produced more than and faster than a designer could do. We read this method as generic because of the production of the numerous and not repeated models which are applicable and compatible with traditional pattern.

Another important feature of this research is a current urban problem is handled during this workshop. As mentioned above Gaziantep traditional pattern is getting lost day by day and it gets harder to see the characteristics of old houses in new settlements. With this study a guideline for new architectural designs; facade and form alternatives and mass customization which suit to the characteristic of the pattern, could be proposed.

As we handle this study from the view of design education; the participants of the student workshop had a chance to experience the computational model conducted with a parametric design process of a real design problem. Furthermore, after this workshop we observed that some of the students developed their semester project by using this method.

Another circumstance that we experienced is the difference of the productions of the first and second day by means of creativity. First day of the workshop came up with satisfactory productions because all participants had some theoretical knowledge about fractals. As far as they knew less about lacunarity, the productions of the second day weren’t as satisfactory as the first day, nevertheless they got an awareness about lacunarity.

While this method have several affirmative affects, one of the privative features of it that we observed is similar parametric values give similar outcomes. This circumstance reduces variety and the creativity level of the outcomes.

Although this study focused on mostly on form generation our aim is to improve this model with the extension of number of parameter and attribute such as relational form and functional parameters to produce generic urban patterns and new urban configurations for new settlements.

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