DEVELOPING A NEW APPROACH OF COMPUTER USE 'KISS MODELING' FOR DESIGN-IDEAS ALTERNATIVES OF FORM MASSING

A framework for three-Dimensional Shape Recognition in Initial Design Phases

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Abstract. This research aims at developing a new approach called 'KISS Modeling'. KISS is generally a rule of 'Keep It Simple, Stupid' that will be applied in modeling process investigated and presented by the research. The new approach is implemented in a computer program 'KISS Modeling' that generates three dimensional forms based on simplifying the concept of shape recognition in design. The research, however, does not employ totally concepts of shape recognition or shape understanding in Artificial Intelligence and psychology. The research, in summary, investigates and describes: 1) a new approach of computer use contributing to generating design-ideas alternatives of form massing in initial design phases, within a simple way that any designer can understand at single glance, 2) implementation of shape recognition for generative three dimensional forms, 3) function to generate different outputs from different recognition, and 4) case studies introduced through applications and functions of the three dimensional modeling system presented by the research. The research concluded that the introduced processes help the user improve the management of conceptual designing through facilitating a discourse of his/her modeling of design-ideas massing.

1. Introduction

Computer, through many approaches of use, has been a medium for aided architectural design. The underlying assumption of this research approach is that architectural forms digitally generated by algorithms may have surprising results. However, delaying the validation of form, until it is completely generated, strays the content of design away from the important architectural needs. The first arrangement of design problem, especially on conceptualization and formalization, has long lasting effect that can be hardly modified in later design stages (Schon, 1983, and Rowe, 1987). Consequently, processes of form creation and decision-making especially on immaterial issues should be conducted by the architect, while computer help could be limited in masses exploration of design ideas, in other words in helping designers to better imagine and visualize.

This research attempts at integrating the view points of previous researches on computer modeling systems in an innovative approach. These view points can be summarized within the following two sides: On one side, all what has been done in the areas of shape recognition, design cognition, and form generation through computational power is more prominent in the two dimensions than the three dimensions, while architecture is more related to the three dimensions. On the other side, performing the whole design process through the computational capability has been criticized by many researchers (Brown, D., 1998). As logical processes of computation in three dimensions that portend to facilitate conceptual design process can never replicate the designer's experiential world (Gardner, B., 1998), without major limitations, e.g. in complexity level, in cost, etc.

This innovative approach of the modeling system introduced by the research endeavors to combine main advantages of the previous research view points and their approaches.

2. Motivation

The main motivation is to present a modeling system that introduces transformations and changes of form assembling within only one-simple-step change at a time, in order to recognize the change occurred in the spatial relationship of form masses. In other approaches such as, reasoning, design cognition, emergent shape and shape recognition, the transformations from the original design to the resulted designs may not be recognized or identified by the users. Therefore, instead of computationally applying a combination of different rules to have different transformations in one step, the proposed modeling system applies one simple rule at one step. This motivation illustrates using the rule of 'keep it simple stupid' in the presented modeling system.

In other words, our motivation of the presented approach 'KISS Modeling' manifested in the creation of design-ideas alternatives of form massing in the initial design phases, is to benefit from the computational power of three dimensional modeling systems in conjunction with the designer's experiential world in conceiving and perceiving the masses at hand.

Case studies are presented and classified in terms of tracking different output from different recognition which, it is envisaged, will increase the efficiency of the conceptual design activity through the use of KISS modeling.

3. Objectives

The research aims at investigating and proposing: 1) implementation of shape recognition for generative three dimensional forms, 2) function to generate different output from different recognition, 3) process to generate three dimensional masses from space layout data, and 4) analysis the usefulness of the proposed KISS Modeling as an innovative tool that facilitates modeling, conceptual design, and creation of design-ideas alternatives of form massing.

In summary, our main objective is to introduce a framework where shape recognition and generative systems are encapsulated; in order to develop a Simple Stupid process of generating designs, which any designer can understand and use at a single glance.

4. Previous Researches Related to Our Research

Shape recognition has been investigated through many researches, especially in the two dimensions. The research attempts to shed more light on this realm. Many researches maintain the computational capability of performing main processes of design, such as interpretation of two dimensional drawings or implied-shape recognition in two dimensions. The following discussion concentrates on the details of these investigations.

The center for artificial intelligence in the University of Sydney has been searching the computational capability in the design process for over three decades, in areas of: reasoning, design cognition, emergent shape and shape recognition. Many contributions and accomplishments have been made in these foregoing areas. The distinguished results of their researches related to our research can be summarized in the following discussion:

Computational processes already exist for: the perception of figures and gestalts (Gero and Yan, 1994), the appreciation of qualities (Reffat and Gero, 1998), and the capability of recognizing unintended consequences of actions (Gero and Saunders, 2000). For example, Gero and Saunders (2000) presented a computational model of designing using situated processes that construct representations (Gero and Saunders, 2000). Gero and Maher (1991) suggested using reasoning by analogy to bring in innovative solutions (Gero and Maher, 1991).

Soufi and Edmonds (1995) introduced a presentation and interaction model of implications for design support through shape emergent, which presented different approaches have been previously made and developed in the cognitive basis of two dimensional shapes emergence. Different applied methods of: Pixels, End Points, Regions, and Line Segment have been presented. Some results and the proposed role of user have been introduced (Soufi and Edmonds, 1995).

The computer approach of Shape Grammar also has many distinguished results in the computational capability of form creation and shape recognition within the design process. In two dimensional Shape Grammar research papers, Shape grammar is given to define languages of architectural and other similar kinds of spatial designs. Main details of the functional elements comprising designs in these languages are provided in the informal, verbal descriptions of the shape rules used to compose spatial elements in designs (Stiny, 1977; 1980; Stiny and Mitchell, 1978; 1980; Knight 1980; 1981; Flemming, 1981; Downing and Flemming, 1981; Knoing and Eizenberg, 1981). Knight described a formal model for defining transformations of languages of designs in terms of the grammars which generates them (Knight, 1983). A fundamental problem in editing shapes has been investigated through the recognition of partial shapes in a drawing to which changes are to be made. In addition to, the possibility of using shape rules as mechanism for effecting such changes is explored (Krishnamurti and Giraud, 1986). Within a similar context of a related research area, the maximal representation of a shape is defined and algorithms for shape arithmetic are developed (Krishnamurti, 1992).

In three-dimensional Shape Grammar, shape grammars are given for the generation of plans and for articulation of plans. Shape grammars emphasize aspects of geometry and overall design and explain how individual parts and features are related to each other (Flemming, 1987). The subshape recognition problem for shapes under the linear transformation is investigated. As a corollary, an outline of a procedure for determining the symmetries of a shape is presented (Krishnamurti and Earl, 1992).

In other approaches of Genetic Algorithms and Generative Design Systems, a general model of design space, basic navigation operations, and principles for designing navigation support was investigated. The design space model described how the space might grow and evolve along predictable dimensions. The basic operations facilitated navigation activities in this multi-dimensional design space were presented (Chien, 1998). Parish and Muller (2001) proposed a system using a procedural approach to model cities, depending on that every urban area has a transportation network that follows population and environmental influences, and often a superimposed pattern plan. In their model, the virtual buildings appearances followed historical, aesthetic and statutory rules (Parish and Muller, 2001). Muller et. al. (2006) introduced Shape grammar for the procedural modeling of computer graphics and architecture (Muller et. al., 2006). First, the presented grammar generated procedural variations of the building mass model using volumetric shapes, and then proceeded to create façade detail consistent with the mass model (Muller et. al., 2006).

The possibility of encoding architectural design intentions into a generative design system was investigated. Caldas and Norford (2001) presented a generative system that acts simultaneously as a diagnosis mechanism for problems occurring in the existing building. Results suggested this generative system may be a useful tool to architects during the design process, by identifying potentially problematic areas and suggesting ways to approach them (Caldas, and Norford, 2001). Emergent and multiple-evolutionary system for designing and architecture is investigated (Yamabe, Kawamura, and Tani, 2006). They concluded that spontaneous evaluation and synthesis of architecture are possible with the introduced system using multiple genetic algorithms (Yamabe, Kawamura, and Tani, 2006).

The question that appears is: why concepts of Shape Grammar, Shape Recognition, Case Based Reasoning, Design Cognition, Emergent Shape or Generative Systems are not Simple or Stupid. In Shape Grammar and Generative Systems, we cannot understand the whole generating process from the starting point to the ending point at a single glance, though each rule can be understood easily. While in Shape recognition, Input and Output is easily understood, but most of the study does not allow to generate other scenarios. Recognizing the whole computational processes is so complicated to the extent that it is difficult to decompose these process into pieces in order to be rearranged.

5. KISS Modeling: framework and computer program

There are two main approaches applied in the modeling systems: formal properties of geometry, and design knowledge. The proposed approach of computer use in three dimensional modeling systems, presented by this research, is to combine these previous two rules with allowing architects and urban planners to interact and transform designs displayed, Figure 1.

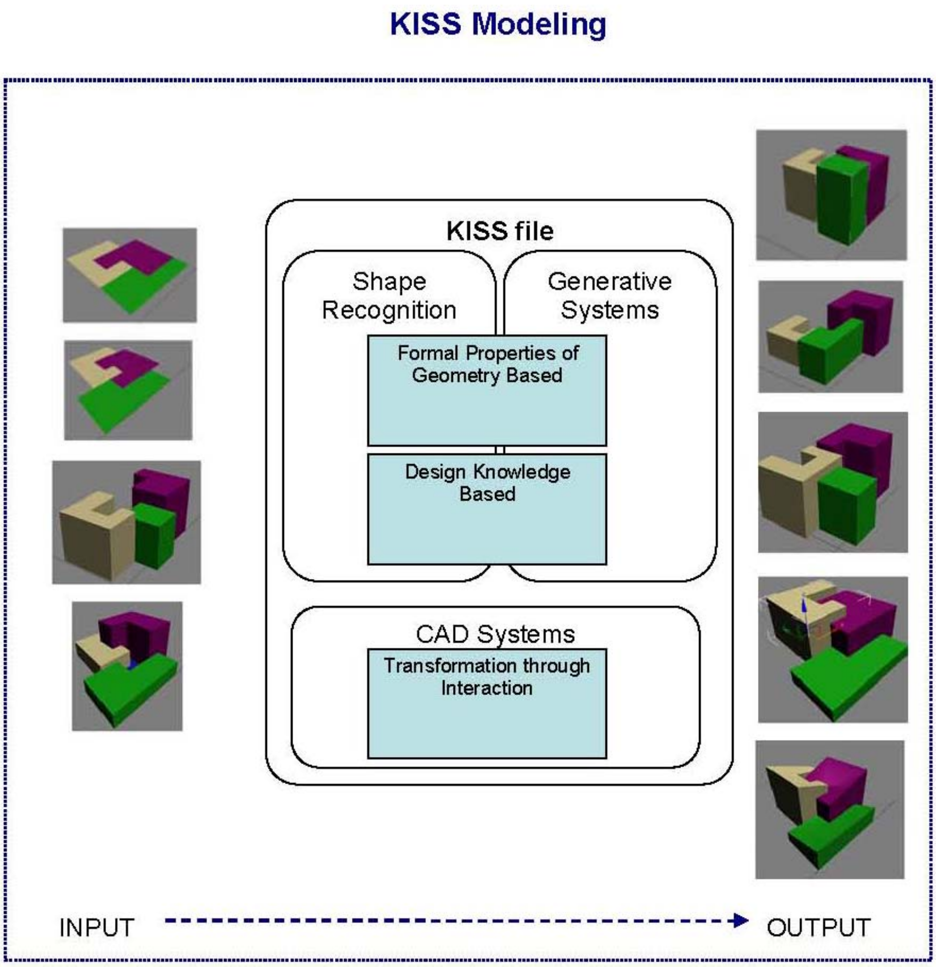

Figure 1. *Framework, methodology, concepts, and some case studies of the introduced KISS modeling system.*

The design knowledge interpretation is conducted by the user, according to his/her conception and perception of the presented design, where each user can perceive and conceive the designs in a different way according to his/her personal visual design thinking. Consequently, the modifications conducted can vary from a case to another.

Algorithms used in the three dimensional modeling of the presented approach are not totally concerned with applying design knowledge based tasks, leaving almost all of these cognition processes within the role of users. Moreover, algorithms applied the simplicity rule within each transformation step that results in a new design modified from the original or previous design. Users, therefore, visualize and follow up each transformation of their designs whether this transformation occurs through interaction or algorithms.

5.1. SYSTEM FRAMEWORK

The presented framework applies a new method in the creation of design-ideas alternatives in form massing, through utilizing space layout data to produce three dimensional forms. Space Layout Data is a set of spaces in two dimensions or three dimensions, and each Space Layout is used as an input in KISS modeling.

In implementing the system, three main objects are defined: Space, Design and Subspecies. Space is a class of a list of cells occupying in a grid. Design is a class of a list of spaces. Subspecies is a class not for a new deign but for the design whose topology is not changed from the parent design. A new design is generally generated when a new set of spaces or a new neighborhood of conditions is created from its parent design. The lists of all spaces, designs, and subspecies are saved in a file.

5.2. METHODOLOGY AND CONCEPTS

The system methodology and concepts, Figure1, can be described as follows:

5.2.1. Methodology

Three steps illustrate the system methodology:

Step 1, Data Creation, it is a step to create a space layout data, which is a set of Spaces. A unique property index number is selected to each Space from a predefined list. The data is checked if it is a new Design or Subspecies, and it is added to the list of Designs or Subspecies.

Step 2, KISS File, it is a step to create a new KISS file or select a file from the preexisting list.

Step 3, Generate, it is a step to generate a 3D object. In 3D Studio Max, the KISS file is executed with the space layout file, and a 3D model is generated and saved as 3D formatted files. The rendered image is also saved.

The system is implemented in Java and can be run in a Network environment. Any user can access to the program. The three dimensional output objects are generated using the list of spaces and attributes of spaces.

INPUT Data: Shape Recognition File (or KISS file). So far, the system supports to execute Max Script and original formatted files.

OUTPUT Data: The output data is a 3D model file and rendered image file. This program does not generate a 3D model by itself, but execute 3D modeling and rendering package software and send requests to generate outputs with a KISS file in the software as a middle ware.

5.2.2. Concepts

In order to achieve the main aim of the program presented, the following concepts are implemented.

- Using algorithms to generate a new design: First, the original combination of objects presented by the architect is analyzed and classified by the program into main objects. Second, each object is defined through three classes: Space, Design and Subspecies. Third, rules of extracting new shapes are applied through a new condition of relationships and a new set of spaces. Forth, the new relationships that are created are saved in a separate file. Forth, lists of all spaces, designs, and subspecies are saved in a separate file. Fifth, the program displays the extracted shapes according to the lists of their spaces, designs, and subspecies.
- Editing the displayed designs: The proposed tool of modeling system offers number of ways in order to modify the displayed design. These ways are illustrated in the next part of the research.

5.3. FUNCTIONS

KISS modeling allows architects and Urban Planners to visualize and share two and three dimensional designs. The main function of the program is to generate three dimensional forms (alternatives of form masses) derived from the original combination of forms (design-ideas of form assembling) proposed by the architect.

Functions offered through KISS modeling enable the users to transform the designs displayed or uploaded, through two different ways: 1) interaction by modifying the designs in a simple way of editing and transformation, and 2) computationally generating by algorithms written in Max Script language to upload a new design.

The functions introduced by KISS modeling are: 1) Zoom Scale, that enables the user to search the presented layout of designs, through zooming in on each node and its branches to choose a certain design to display, and zooming out to select a different part of the layout from which another design is selected to display, 2) Add Button, that allows to add new objects to a new design or an exited design, 3) Transform Button, that offers different ways of transformation applied at the masses at hand –move, stretch, rotate, etc.-, and 4) Delete Button, that allows to delete any mass or object of the displayed designs. The introduced functions, thus, can be described as a powerful design tool linked to areas of Shape Recognition and Design Alternatives.

6. Case Studies

This part of research introduces and classifies case studies, which are implemented through applications and functions of KISS modeling, in order to investigate the program outputs as design ideas alternatives contributing to form massing employed in conceptual design.

Program output can be classified into four main categories: Transition, Deformation, Detailing, and Transformation, Figure 1, 2 and 3.

- Transition: there are two types of transition introduced through shape recognition processes of the program: from two dimensions to three dimensions, and within three dimensions, Figure 2.

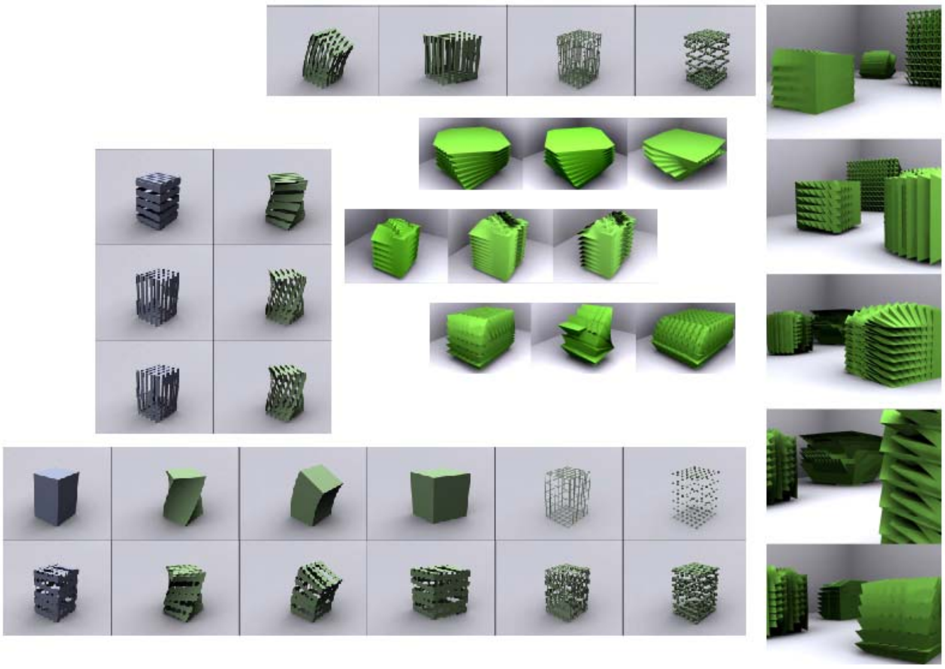

Figure 2. C*ase studies of KISS modeling system, transition and deformation.*

- Deformation: Two types of deformation are represented through shape recognition processes of the program: 1) in two dimensions, and 2) in three dimensions, where the introduced results of deformation in three dimensions can also be seen as different outputs according to shape recognition processes or according to the perception and conception of the user.

- Detailing: KISS modeling offers an option for the user to create and visualize the form masses in some details in two and three dimensions. This detail contributing to visual design thinking employed into conceptual design helps the user improve the management of conceptual designing processes.

- Transformation: KISS modeling allows the user to transform the masses at hand in two and three dimensions. Design-ideas of form-massing generated by Max Script and created by functions of KISS modeling can be transformed by the previous two ways, introducing alternatives of the original design ideas for the user.

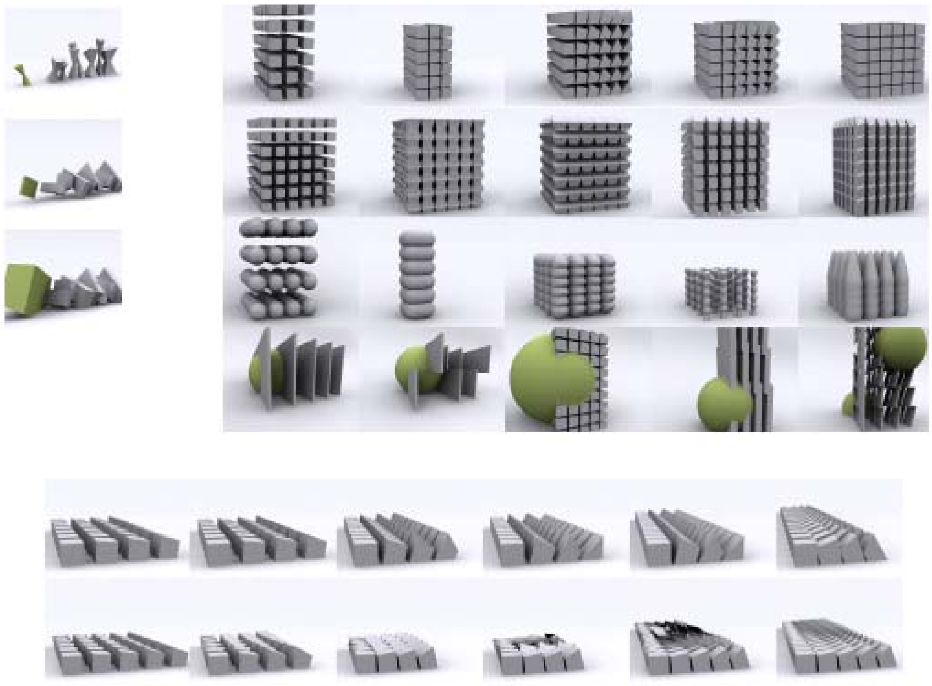

Figure 3. C*ase studies of KISS modeling system, detailing and transformation.*

7. Conclusion

The research proves the effectiveness of the new approach of computer use 'KISS modeling' introduced within a three dimensional modeling system. The program outputs introduce the implementation of shape recognition for generative three dimensional forms in design, through creating different outputs from different recognition and generating three dimensional masses from space layout data.

In view of the previous investigated results, the research forms a better understanding and a solid basis of innovative specific processes for computationally generating design-ideas alternatives in initial phases of the design process.

From the introduced applications and their analysis, the presented modeling system has: 1) effective assistance for the user to improve the management of conceptual designing through facilitating a discourse of his/her design-ideas masses, and 2) various applications into many areas of initial design-ideas of the design process.

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