AUTOMATION OF PASSIVE SOLAR DESIGN SYSTEM

Subtitle Solar responsive design tool using Ecotect and genetic algorithm

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Abstract. This research, focus on the automation of passive solar design system using computational method. The quantitative nature of passive solar design system makes the automation possible. The automation is done in stages, because implementing the passive solar design system is not an isolated process, but intertwined with the overall design process. The first phase of automation concentrates in conceptual stage, to avoid major deviations in later stages of the design. The conceptual stage use Eco-grammar (A preset Design guidelines for corresponding climate) and user inputs for initial form generation. The second stage of automation is done after the user finalize the model with respect to its position rotation and arrangements. In this stage manipulation of vertex, edges and faces of the forms were manipulated using genetic algorithm. The value of mutation or crossover done in genetic algorithm is suggested by knowledge engine (preloaded design knowledge). Until the form obtains or reach closer to the desired values of performance the loop between analysis and mutation, crossover will be continued. On the basis of analysis result further manipulations may change from the previous which is guided by the knowledge engine.

Keywords: Passive solar system, Performance analysis, Automation, form generation

1. Addressing the problem:

Most performance analysis tools aid architects in simulating solar performance of built form and presenting graphic results. In the above case, solar responsive design depends upon the understanding of the cognitive result and exhaustive process of design and analysis by the user which further increases design duration. Automation of passive solar design system avoids the user to concentrate more on quantitative parameter (solar passive design system) in the design process. The Automated solar passive design system will be more accurate and made reliable by a strong knowledge engine. The research facilitates the designer to achieve passive solar design system without having expert knowledge in corresponding climate condition, which further leads him to concentrate on the quality aspects of the design.

2. Process Involved In Solar Passive Design System

- Conceptual stage (Ecogrammar)
- Design development stage (User intervention)
- Refining the design for solar passive design (Genetic Algorithm)
- Material recommendations where sacrificed on solar passive design system due to user priority. (Ecotect)

3. Proposed solutions and methodology:

The methodology enforces the design process to have solar performance character (position, proportion, rotation) in the conceptual stage itself. For this Firstly the Ecogrammar which is a preset passive solar design guideline based on the geographic location, required user inputs and dijkstra's algorithm is used. In the second phase, the exhaustive process of design and analysis is made rapid using genetic algorithm a computational model supported by knowledge engine. Ecotect will act as a fitness function in Genetic Algorithm process. The second phase of automation the manipulation of forms is restricted to only 20% - 25% of its original value to avoid major deviations in design. In between the first and second phase of the automation user intervention is required to make the design development and finalize the design with respect to the parameters involved in the conceptual stage.

3.1 CONCEPTUAL STAGE:

The initial 3d form will be generated with user information about the program typology and primitives. For typical program typology, preset spatial hierarchy and spatial relation ship will be used to generate the form and circulation will be based on the Dijkstra's shortest path finding algorithm. Ecogrammar constraints will be embedded in the conceptual stage which takes the first preference.

3.2 DESIGN DEVELOPMENT STAGE.

The above generated form may not satisfy the designer in many aspect, hence the designer is given privilege to edit the model without affecting the program hierarchical relationship and Ecogrammar. This stage involves only user or designer to manipulate with the model.

3.3 REFINING STAGE:

3d Synchronizer:
3d synchronizer converts all the parameters of the designed 3d model such as volume, area, face, vertex and edges of 3d model into numeric values in a datasheet. Each form will have its child object such as windows and doors.

The child objects are also converted into numeric values with its parent ID. Synchronization between the above datasheet and 3d model will be done. This will update the 3d model according to the mutations happened for the numeric values in the datasheet and vice versa. Hence manipulations will be done in the datasheet which will reflect the 3d model before it is subject to further analysis.

The model will be analyzed for day lighting and solar gains using Ecotect performance analysis software and the numeric results will be sent to knowledge engine. The knowledge engine suggests the parameter to be mutated and value of mutation, which does not exceed 20% to 25% of the original value.

The selected numeric value of the parameter will under go mutation or crossover in the G.A process. Whenever these values are altered the numeric to 3d synchronizer will update the Model also vice versa. The data sheet will maintain a separate table for storing the latest numeric values of the vector graphical model of closest to required values.

The above process will be run as an endless loop till the required are desired output is generated.

4. Genetic algorithm process:

4.1 MUTATION

The following mutations will be suggested by the knowledge engine to orient the G.A process towards the required result.

- Moving the position of vertex.
- Moving the height of the form
- Changing the volume
- Moving the face
- Moving the edge
- Rotation of faces
- Rotation of edges

The negative, positive or direction of mutation will be decided by the knowledge engine.

4.2 CROSSOVER:

For the first time, only mutation operation happens so that the mutated 3d model can be compared with the prior model and subject the model for cross over if required. Crossover happens only if selected component of the design is performing well than the other one which has higher selection rank in G.A process.

5. Recommendations:

The mutation or crossover priority will be based on the user priority of comfort in each space. If there is any sacrifice is done in the passive solar design system to maintain the user priority, material recommendations will be given as per standards which would be preloaded.

6. Limitations:

The design automation considers only day lighting and solar insolation in the passive solar design system. On the success outcome of this research other parameters involved in the performance of a building will be considered.

8. Expected contributions:

Information about embedding Ecogrammar (preset solar passive design guidelines) into the design grammar will throw some light into this project. Also Information about 3d synchronizer helps to increase accuracy in this project. Interoperability between software like excel, Ecotect, Max script will help in making a standalone plug-in.

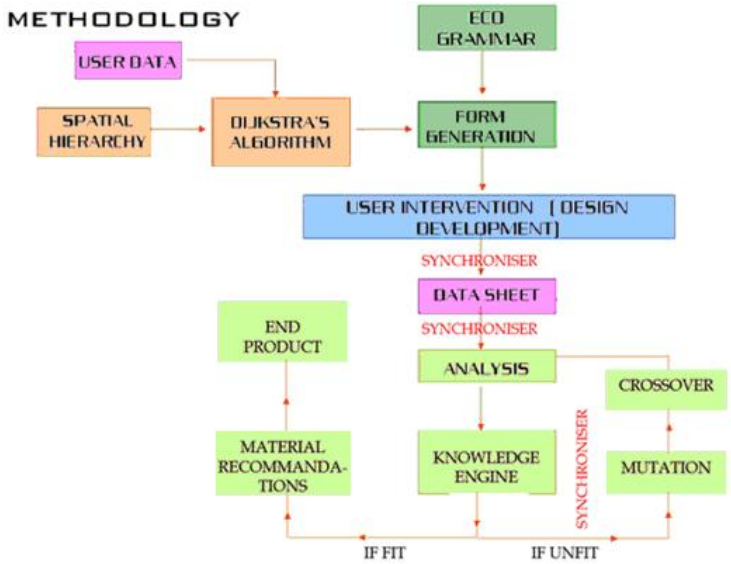

Figure 1. Methodology

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