Intelligent Modelling Of Architectural Design

A FINAL YEAR CAPSTONE DESIGN PROJECT

(Phase-II)

Submitted by

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AND EDUCATION

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Academic Year 2021-2022

DECLARATION

We affirm that the project work titled **"Intelligent Modelling Of Architectural Design"** being submitted in partial fulfillment for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** is the original work carried out by us. It has not formed the part of any other project work submitted for the award of any degree or diploma, either in this or any other University.

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BONAFIDE CERTIFICATE

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Project Summary

Project Title	**Intelligent Modelling Of Architectural Design**	
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Guide Name/Designation	Dr.Mohd Usama, Associate Professor, Department of Computer Science and Engineering	
Program Concentration Area	Genetic Algorithm	
Technical Requirements	Java, Android Studio, Unity and Processing	
Engineering standards and realistic constraints in these areas: (Refer Appendix on page 4 of this doc.)		
Area	**Codes & Standards / Realistic Constraints**	**Tick** ✓
Economic		
Environmental		
Social	Idea of this project is to help the people who are planning to build their own house	
Ethical		
Health and Safety		

		✓
Manufacturability		
Sustainability		

Realistic Constraints:

Social:

There are many people Trying to automate Floor planning using AI. In that many,We were showing some good results and trying to produce good results. We are among certainly same kind of people but with different motives. The people who produced good results with their good algorithms are only accessible to people who are well known about his research and combined knowledge of both architecture and computer science. So To change that We are taking that algorithm to normal people who likes to build their houses with less help of an engineer.

ABSTRACT

The idea is to create a application which helps anyone (even without architectural knowledge) to design a house floor plan by themselves at free of cost. Anyone with basic computer knowledge can design a floor plan using this application and it also encourages creativity and still allows them to stick to their basic needs and resources available(here resource is land space). It gives them numerous options when it comes to choosing a plan since genetic algorithm is used and the user can ask for more generations if they are not happy with the present one. Genetic algorithm is the main algorithm in this application and it not only generated the floor plan but also re-generates the floor plan under user request and KD tree is also used in this application. There is a furnished view for all the plans just to give a better idea to the users how the room would look with appropriate furniture in them and also the connectivity between rooms is based on the placement of the biggest room and rest of the room is build around them and hence it strictly sticks to the user needs and requirements. This application is used to generate a plan for a floor and hence can be used to generate a plan for multistory building by designing every floor one by one or just copying the layout. These layouts are better than hard blueprint layouts because it has furnished 2D view as well which would give the users a clear look onto their future dream house and lets them decide if they are happy with it or else genetic algorithm would regenerate more plans and display it to the user and it is an endless process and the user can ask for infinite combination of plans until they are satisfied with a single plan.

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CHAPTER - 1

1. INTRODUCTION

1.1 Overview

Need of Automation in architechture:

There are many people Trying to automate Floor planning using AI.In that many Were showing some good results some were trying to produce good results. We are among certainly same kind of people but with different motives. The people who produced good results with their good algorithms are only accessible to people who are well known about his research and combined knowledge of both architecture and computer science. So To change that We people take taking that algorithm to normal people who likes to build their houses with less help of an engineer.

Uses of our work:

The Main use of our software is provide middle class people much cheaper way of getting house plans instead of depending on engineers and architects. Our motive is to make this get into hands of the people so that ai in architectural field will reach into hands of common people.It also all possible outcomes from users input this gives user a different perspective of their own home.

Design planning in Architecture:

There are numerous number floor designing algorithm in architecture. Which are used by the architect to design the floor plans according to the users wish list. To Check the Architect whether the plan is within the criteria of user wish. He/she will be creating an adjacency matrix. Below diagram an sample of school building.

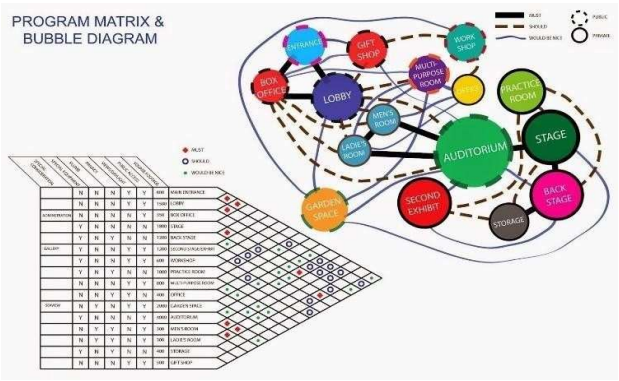

Figure 1:Table for creating adj matrix for Bubble Diagram

Adjacency matrix:

In Architecture an adjacency matrix is a table that helps to show what rooms should be placed near each other. the adjacency matrix is very much useful as a space planning tool, but is useful as a reference. You use it to easily make sure you are giving the user what they need when you move on to space planning via bubble diagrams and block diagrams.

1.2 **Bubble Diagram**:

Bubble Diagram Is an main component for an Architect to Design the house. Since The bubble Diagram is Derived from the Adjacency matrix. It helps to identify the direction of the room placements and connectivity among them. It can be a draft of plan before it get the shape of an layout.

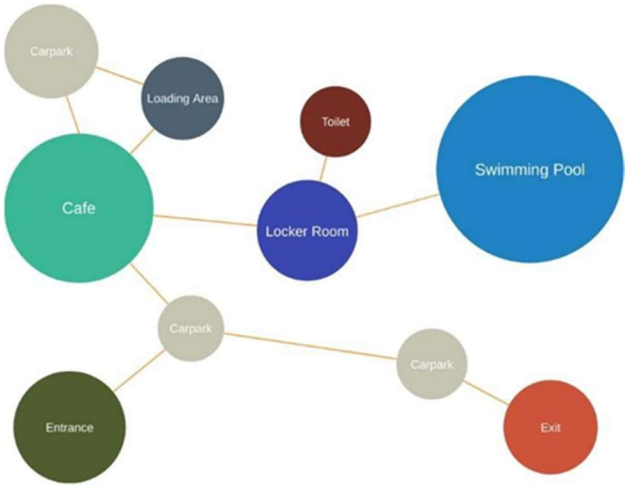

Figure 2:Sample bubble Diagram

1.3 **Genetic Algorithm:**

Genetic Algorithm (GA) is a search based optimization technique based on the principles of Genetics and Natural Selection. It is frequently used to find optimal or near optimal solutions to difficult problems which otherwise would take a lifetime to solve. It is frequently used to solve optimization problems, in research, and in machine learning. So We are using this Algorithm to solve this problem by making numerous number of solution out it and sort out the fitted ones depends upon the users input.

1.4 **Magnetizing Algorithm:**

Magnetizing Floor Plan generator is properly builders at the ground plans. Considering association of all rooms in addition to adjacencies and connections of primary spaces. Our intention is to strive exclusive approach formerly

defined tactics invent a few new strategies and to pick first-rate plan for the person. Floor Plan evaluation turned into performed a good way to recognize the structural styles of communique in houses. Features withinside the ground plan of residence consist of complicated connectivity which include corridors, hall, etc. These connection is taken into consideration for all tiers of improvement due to the fact they offer the overall format of all primary internal spaces. In this studies paper we recognize the improvement nation of pc primarily based totally tactics for ground plan technology and offer a brand new technique primarily based totally on person input, area allocation, flexibility, smooth of use, and pace of technology. Magnetizing Floor Plan generator meets a majority of these traits and indicates the capacity of attempting to find new approach. According to the ee-e book we refer magnetizing set of rules is able to dealing with interactions person aspect on every step and entire assignment with the aid of using itself. Methods are the operation collection evaluation will assist business floorplans to calculate the entire distance from every plan. The wellknown motive of facility making plans is following equation.

$min\Sigma\Sigma dijnj=0ni=1wij$

$where: d = ((Xi-Xj)2+ ((Y-Yj)2$

Magnetizing Algorithm Mechanism:

Magnetizing set of rules connect hall to every of the room. It may be positioned one, two, or 4 facets of the room. First front is positioned close to to the doorway point. Rooms which can be adjoining to already looked after with the aid of using the range of general adjacencies. Room which has greater adjacencies is positioned first. The room ought to be part of hall shape and the mobileular ought to now no longer farfar from all adjoining room. There ought to be area across the room so new room may be positioned efficaciously. If the room is positioned efficaciously then repeat the identical steps for the range of rooms given with the aid of using the user. If the room isn't positioned efficaciously then both preceding room have been positioned now no longer compact sufficient or no area left. The procedure of iterating serves as significance of which withinside the discipline of ground plan technology. After primary technology we will encompass casting off lifeless ends, modify the running gird given with the aid of using the user, including halls/rooms to the hall shape. In this contemporary generator all of the rooms can in shape right into a boundary length given with the aid of using a user. By magnetizing set of rules all of the rooms into the boundary can set up in seconds or minutes. If the boundary length is big it make the effort to set up.

Evolutionary Algorithm:

Evolutionary Algorithm is the solution for the Automated Floor Plan Generation. The paper we refer covers the extensive description and explanation of genetic algorithm operator and fitness function definition. Evolutionary Algorithm works in four steps initialization, selection, genetic operators and Termination. Evolutionary Algorithm structure is schematically presented. The work starts with user input and design according to the data given by user like number of rooms, area, location. Evolutionary Algorithm is based on the use and function of the recreated architectural process in stages of the software workflow. Collecting and usage of authentic architectural design of the data to make an appropriate design solution. Giving a brief review on the problem of the architectural design practice. Automated Floor Plan Generation mentioned here . The proposed algorithm creates the floor plan using the list of dimensions area scale factors and sequence of rooms ordering. In Evolutionary Algorithm development, creation of effective mechanic of floor plan generation and optimization methods is as important. Automated Floor Plan Generation problem follows several rooms defined by the user and the solution is to arrange them and fixing their size to the user input.

Plan Layout:

The field of automation in floor plan layout focuses on how computers can aid in this process. Finally Algorithms tend to work with some rectangular boxes with user input. Many floor plan automation have focused in optimization through ideal qualities. In this paper the idea is explained well how computer playing major role in understanding and defining ideal qualities of design. For testing space layout divided in two main steps. First step is to create a algorithms capable of producing designs that includes to satisfy the fitness functions criteria. This part create a housing solution with measurements and locations. The second part is to evaluate housing according to the input given by the user.

CHAPTER - 2

2. LITERATURE REVIEW

2.1 Magnetizing Floor Plan

Gavrilov Egor, Schneider Sven, Dennemark Martin, Koenig Reinhard [1] It takes into account the location of all rooms, as well as the continuity and connectivity of the main space. Our goal is to try out the different methods described earlier, approach them, invent new technologies, and choose the plan that works best for our users. The floor plan was analyzed to understand the communication structure of the house. Features of the house floor plan include complex connections made up of corridors, connection between each corridors and space between them.

2.2 Hybrid Evolutionary Algorithm

Maciej , NisztukPaweł B. [2] Evolutionary algorithms focus on ease of use and functionality achieved by emulating architectural process steps in a software workflow. Intuitive helpers for user interfaces and workflows. Collect and use real-world building design data to create the right design solutions. Completion of work based on architectural design practice. The scoring function used and the greedy algorithm allow us to find the (almost) optimal solution. The floor plan description is too simplistic. It is based on the outline of a rectangular room. Constrain the floor plan to a rectangle.

2.3 Evolutionary Methods in House Floor Plan Design

Katarzyna Grzesia, KopećBarbara Strug, Grażyna Ślusarczyk [3]. This study proposes the use of evolutionary strategies to create novel design solutions to the floor plan problem. The genotype is represented as a vector of numeric values of points representing the endpoints of the barrier. Evolutionary methods are proposed as methods of generating new design solutions, whose genotypes are represented in the form of numerical vectors. The proposed original presentation is simple but at the same time intuitive and expressive.

2.4 Evolutionary Algorithm Based methods for Layout Generation

Reinhard KoenigKatj, KnechtKatja Knecht [4] We compared the sealing and subdivision algorithms as two methods based on evolutionary algorithms for creating rectangular architectural layouts, and the two respective layout solvers in terms of performance. The speed of finding possible solutions, the reliability of finding the right solution, and the distribution of the solutions found. Both systems are practical solutions for automatically creating floor plans as part of a complex planning process

2.5 Architectural Layout Evolution

Nizam onur Sönmez. [5] This allows you to use standard graphic media to create versatile computational layout assistants that can be easily integrated into your day-to-day design process. The capabilities of the approach were detailed and demonstrated in this work, and the resulting assistant's versatility, intuitive graphical interface, and use cases were also demonstrated**.**

2.6 Evolutionary Design and Multi Objective Optimisation

Dragan Cvetkovi´c, Ian Parmee. [6] In this study, we review existing methods of optimizing multi-criteria features while solving pre-design problems. Literary methods are being studied and new methods are being introduced.All methodologies are evaluated as part of a joint design effort for the entire aircraft system, while highlighting the fundamental issues and challenges of the preliminary design methodology.

2.7 Space layout planning

Jun Hyung Jo, John Gero. [7] This study proposes a design strategy based on the construction of a genetic/evolutionary design model based on the concept of natural genetics. We propose a schema concept for expressing design information in a model. The usefulness of a model is determined by its computational efficiency and its ability to generate satisfactory answers for a given set of problem criteria. To demonstrate this technique, the main problem of office layout planning, which entails the topological and geometrical construction of spatial elements, was used. Examples are taken from the literature.

2.8 Genetic algorithm for multi-floor facility layout problems having inner structure walls and passages

Kyu-Yeul Lee. [8] This research provides a new genetic method for calculating solutions for multi-floor facility layouts with inner structure walls and corridors. On gene architectures, the proposed algorithm models the

multi-floor layout of facilities. A five-segmented chromosome makes up these gene structures. Selection, crossover, inversion, mutation, and refining of these genes for successive generations provide improved solutions. An adjacency graph depicts all connections between the facilities, corridors, and lifts. The graph theory algorithm Dijkstra's algorithm is used to compute the shortest path and distance between two facilities.

2.9 Genetic Programming + Unfolding Embryology in Automated Layout Planning

Adam Doulgerakis [9] Automated planning aims to implement calculation methods for creating and optimizing floor plans, taking into account the spatial organization and work purpose. Sophisticated techniques, including genetic algorithms, were used as heuristics for good decisions. However, fertility from social systems has been regularly neglected. It explores the quest to demonstrate that records encoding sociocultural generative

planning forces can be created within evolutionary apartment planning devices. For this reason, a collaborative apparatus consisting of a genetic programming rule set and an agent-based fully unfolding generative process that assigns sports to generated regions using a GP rule set has been created. The challenge in sports is a recursive process that follows commands coded as permeability diagrams. We also propose and apply the Ranking Sum suitability assessment methodology to perform multi-objective optimization. Its effectiveness is verified using the WeightedSum Fitness feature. The results of numerical and spatial systems are compared with those of traditional evolutionary approaches. This comparison showed that overall the proposed system could provide a better solution.

2.10 Graph Theory and Architecture

L Lakshmi, Madhumathi, M Sindhuja [10] The main areas of graph theory are analyzed analytically and offer a wide range of architectural applications and the design of constructed shapes. In the early stages of architectural design, original concepts were created in 2D. However, as technology gains momentum, today's architectural creations dominate an essentially different, homogenous design style, as was the case in the early architectural era.

CHAPTER – 3

3.1 OBJECTIVIES

To Develop an automated generative layout for a house with the input given by the user (area, required rooms, room space, connectivity)complete architectural structure for the same according to the room connectivity and priority. The room with the biggest area is chosen as the main room(mostly hall) and other rooms are connected and established around it. To create the layout which best suits the user requirements and input. To display the created layout to the user to make sure if they like the presented layout. To use genetic algorithm and make numerous layouts if the user doesn't like the created plan. The plans created using genetic algorithm are ranked based on their design score, the plan with the higher design score is displayed to the user and if the user doesn't like the layout then they can opt for the other layouts created using genetic algorithm. To generate furnished layouts if requested by the user to have a more logical view into the layout. To have doors between rooms where they are connected according to their priority. To convert the generated plan which has been approved by the user into architectural design so that the viewer can have a better understanding of their dream house plan. To make our software available to anyone with internet access and a browsing device and make it user friendly. To make simple to use and easy to understand even without architectural knowledge and allow people to design their dream house floor plan on their own instead of hiring someone to do it for them. To encourage more people to use our software rather than hiring someone in such a way that they are encouraged to use their creativity and still satisfy their own needs using the application

3.2 PROBLEM STATEMENT

- Given a land dimension across four faces [X1,Y1,X2,Y2], the level [L1, L2, L3, L4], the task is to show minimum of 4 different house plans appropriate for the land dimension.
- Level (L) corresponds to the house type. L serves as a determinator for the house type in various aspects including size, amenities, window counts, among others.
- The problem tends to be an optimization criterion, that estimates the objective function with maximization criterion.
- The predicates of the problem being land dimension, shape and level.
- An addition, 2D rendering of the house plan will be the presented in top, front, and side views

CHAPTER – 4

4 Software Requirements

- Unity
- JAVA
- Processing CORE
- Android Studio

CHAPTER - 5

SYSTEM DESIGN.

5.1 Flow Diagram

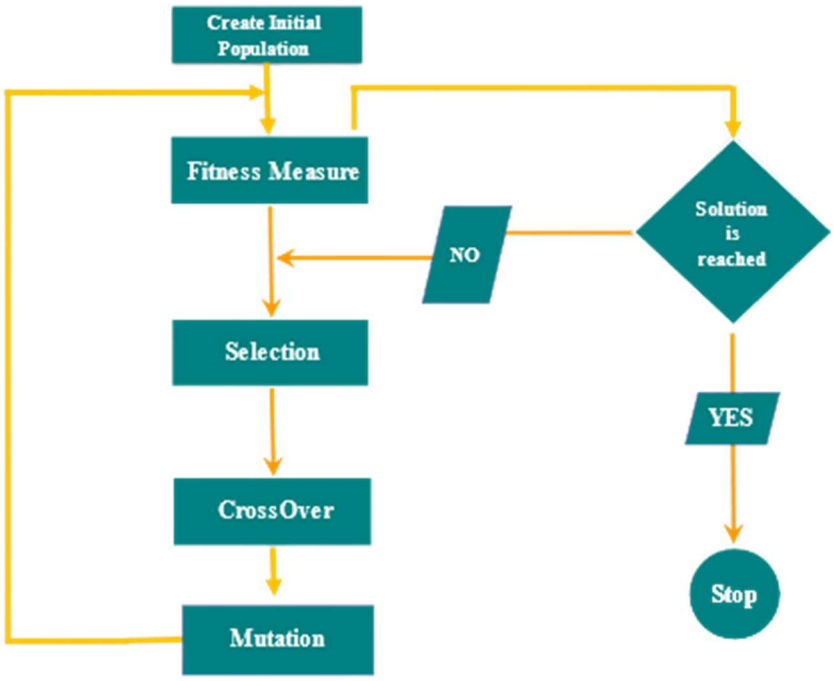

Fig 3: Flow Diagram

5.2 Use case Diagram

Fig 4: Use case diagram

5.3 Engineering Standards and Design Constraints

- ISO/IEC TR 29119-11:2020(en) Software and systems engineering
- ISO/IEC/IEEE 15288:2015, Systems and software engineering
- ISO/IEC TR 24030:2021(en),Information technology — Artificial intelligence (AI)
- IS 962 Indian Standard For Architectural

CHAPTER - 6

DESIGN ALTERNATIVES

6.1 Internal Deliverables

The Genetic algorithm can be used in a way that it helps to get different version or aspect of the floor plans.Each Generation will have different and unique generations.In such a way Each generation may have better version of next Generation.

As a result, the following are our internal deliverables:

- Processing the Algorithm
- Calculating the Rooms Generated
- Generating the Floor plan according to the user input
- Displaying the output

6.2 External Deliverables

Our project's external deliverable is an user application created with unity with package of processing core. Our implemented product will be used by the end-user (common people) as an application to generate house plans or apartment designs without the need of costly engineers. Deliverables are the major goals we set for ourselves to execute the project as planned and on schedule**.**

CHAPTER – 7

7. PROPOSED APROACH

7.1 Existing System

A hallway is connected to each of the bedrooms. It can be placed along one or four sides of the room. The hallways then shape the whole conversation community between the rooms. The first front piece is placed near the tip of the door. All pieces adjacent to the already placed piece are healed by identification in their general neighborhood. Room R1 with the greatest adjacency is placed first. For this, the entire shape of the already positioned corridors is analyzed; the alveoli, which satisfy similar needs, can be considered as alveoli for fitting out a brand new room: given threshold (values 2 four best squares) There must be an area around a piece of furniture, therefore the any new part can be placed there. is placed next to this cabinet. It is essential that the piece of room R1 is related to the whole shape of the room. If the R1 piece was placed successfully, go back to the 3rd step of the process where the area of the different pieces will merge evenly.

7.2 Issues In Existing System

As we discussed earlier in existing system the algorithm which was proposed in existing system only separates the area for each and every room within a given area of house corresponding to input dimensions. The allocation of spaces to rooms are mostly fragmented, resulting in non-contiguous free space in the end design and these free spaces cannot be efficiently used. Their implementation is very platform specific requiring high learning curve and requires knowledge of architectural programming

7.3 Proposed System

Generation of architecture using Architectural intelligence algorithm in both 2D and 3D designs. Development of software useable for all domain of people. Clear view of whole designs. Newer generation and newer designs on each iteration which leads to new way of seeing designs that normal person could not.Most efficient Generation on each iteration.

7.4 Advantages of Proposed System

- Design based analysis on each generation
- To Develop architectural structure Design
- Convert generated layout to 2D architectural design
- To make architectural design as a good platform and user friendly platform to make their own house with his creativity

7.5 Methodology

Developing the connectivity:

Before Applying Any Algorithm Creating Connectivity Between the Rooms within Created Within the Area is important. Since the connectivity will helps to evolve the algorithm to its best case.Connectivity can be created by Creating Node For Each rooms. Consider A Single Room As Rectangle or Square using midpoint formula we can find the center point of room. Which will be further added as node N.

For Example:

if you represent your rectangle or square as 2 points (two opposite corners) you would have to use the following formula:

p0

\+ +

| |

| |

\+ +

p1

center.x = (p0.x + p1.x) / 2

center.y = (p0.y + p1.y) / 2

Using Above formula Each center point of the Rooms Are Found and will be added as node N.N will be Representing The Sequence of number 1 to n

Sequencing and Creating Edge:

After Creating the Nodes for the Rooms in the House There is no order in which room Must be placed First and which room to be last.So we made a Default node as hall which was sequenced as number 1 node. After Every room added next to the hall will be consider as next following Sequence number Then other room sequence will be depends upon the user input.

For Eg: Since the Hall is Default one use can not remove or change its order.If user Adds Kitchen As Second Room then node 2 will be the kitchen.

Note: Above Explanation is about connectivity not about room placements

After Sequencing of all Rooms and Node The connectivity of the nodes will be Created by Edges. This is same method we used in native graph strategies. The Edge Connectivity is also defined by the user. The user does not know it is an Edge Creation. The user Will be Defining Where they want the Room Entrance should and From Which Room it should be. Through this we are able to achieve two things one is connectivity and second is door placements.

Designing Of Tree for the house

Since we Are Trying to implement kd-trees we are using binary tree for Tracking the subdivisions of each rooms in given area.The Base will Started to separate subdivisions of two until certain plan is achieved. Inner nodes Indicates node with greater Size.

Sample Tree for an House

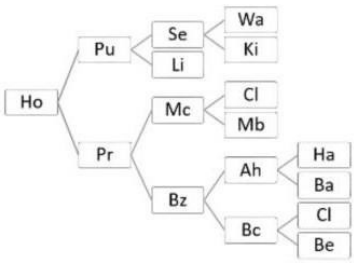

Figure 5: Tree of the House

Evolutionary algorithm:

Now it is time for get into the actual algorithm of generations. There are lot of Algorithms in category of Evolutionary algorithm. But for this problem we are going with genetic algorithm. In short, the criteria (minimum size, area, etc.) for each room are measured in a floor plan database. The mean value of the criteria becomes the optimal representation of the floor plan. The standard deviation of the mean would measure how consistent or inconsistent these criteria are. For minimal size and area, this measurement is really easy. A consistent plan indicates that the pattern is repeated across all plans in the database. When comparing measurements, a standard deviation of 0.00 would mean a consistency of 100% and a consistency of 0% would result in the maximum possible distribution of the data. A plan can be imagined as a point in multidimensional space. Every point of every room is a point in a space. The position of the point is determined in each space by the size measured in the criteria. Positions in a database determine the most representative floor plan. To find how a new floor plan similar to an existing floor

plan database, the distance from that point multiplied by the consistency of the mean for each point in space would define how much a new floor plan design follows the design criteria in a dataset . It has to be accepted that selecting the average position of a database to represent a design can mean it can be too easy.

In the field of enumerative combinatorics Catalan numbers determine the total possible combinations of trees for a given number of nodes (Stanley, 2013). The Catalan number describes the relation of the total number of inner nodes to the possible number of trees. In this case the number of leaves (rooms) is a more relevant number to relate to, so, the number of trees is calculated as the Catalan number of leaves minus one. If this number is multiplied times the factorial of n, this would formulate all the possible arrangements of rooms in a determined tree, and times 2 for every inner node to determine if the subdivisions are made in x-x or in y-y.

Cn=((2n)!)/((n+1)!n!)

Cn=((2(n-1))!)/(n!(n-1)!)*n!2(n-1)

Genetic algorithms have the following advantages over other methods: “there is no need to determine restrictive assumptions, dimensions can be explored in continuity, and explores answers within an acceptable efficiency”. (Jo & Gero, 2006). Genes are divided into 4 main categories depending on the function they perform. By varying all genes, a fitter solution is searched from all possible rectangular arrangements **.**

Type 1:

It controls binary tree number. There is one global gene type 1 for the tree. If n is the number of rooms there are Catalan number possible outcomes for this gene.

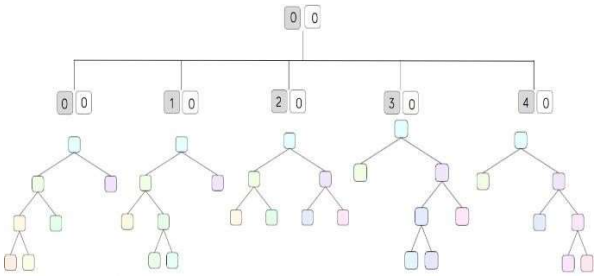

Figure 6:Gene Type 1

Type 2:

It controls how rooms are assigned to the corresponding node. There is one global gene type 2 for every tree. If there are n number of rooms, there are n! number of possible outcomes for this gene.

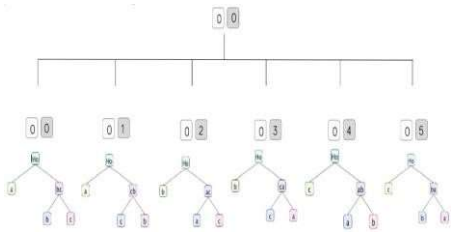

Figure 7:Gene Type 2

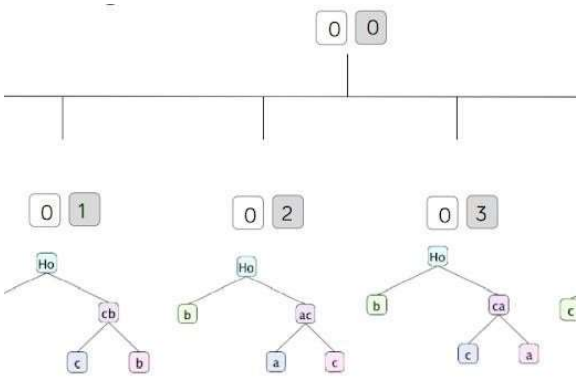

Figure 8:Gene Type 2 zoomed in image

Type 3:

It controls the arrangement of the subdivision. If there are n number of rooms there are n-1 number of genes. it can either be 0 or 1. If the gene's value is 0 the inner node would subdivide in x-x. If the genes value is 1 the inner node would subdivide in y-y.

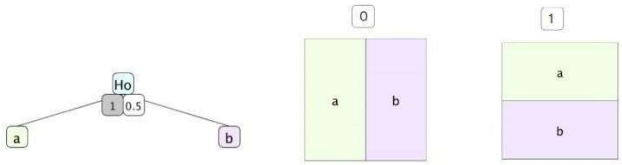

Figure 9:Gene Type 3

Type 4:

It control the percentage of space given to each subdivision. It goes from 0 – 1 by steps of 0.01. There are the same amount of genes type 4 as genes type 3.

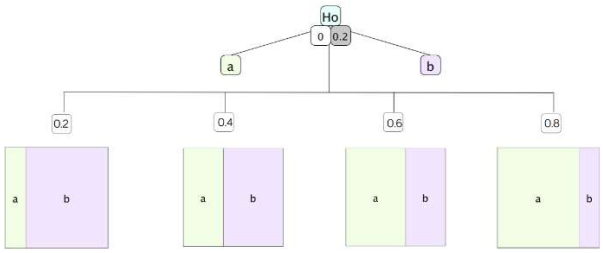

Figure 10:Gene Type 4

Fitness Function:

Floor plan compactness fitness function:

The function ComptactnessFitness evaluates the floor plan compactness by determining its bounding box area B and reducing its value by the summed area of all rooms. If the value equals 0, the rooms cumulative surface covers the floor plan bounding box meaning there is no lost space and the floor plan is the optimal one.

$$\text{CompactnessFitness} = B - \sum_{i=1}^{n} (w_i \cdot l_i)$$

Room area fitness function :

The function evaluates the area of each room based on the value of preferred area Ai provided by the client for a given room, during the design data input.

$$\text{PreferedAreaFitness} = \sum_{i=1}^{n} |A_i - (w_i \cdot l_i)|$$

Room preferred location fitness function:

The function evaluates the location of rooms in relation to four world sides (North, East, South, West). First, the location of all rooms is translated to list of edge indexes determining which edge of room rectangle should be outer.

$$\text{PreferedLocationFitness} = \sum_{i=1}^{n} (ED_i - ed_i)$$

Room proportions fitness function:

This evaluation function measures the length-to width ratio of each room.

$$\text{ProportionsFitness} = \sum_{i=1}^{n} \left| \frac{5}{3} - \frac{w_i}{l_i} \right|$$

Room ID	Room Name	Room Width	Room Height	Area (sq. m.)	Room Location
1	Hall	750	1090	81.75	East South West
2	Kitchen	410	600	24.6	North East South
3	Single bedroom	460	780	35.88	North South West
4	Single bedroom	580	370	21.46	North East
5	Bathroom	750	410	30.75	North West

Fig 11: Data of rooms with their room location

Fig 12:Plan generated from the above table

CHAPTER – 8

MODULE DESCRIPTION

8.1 User Interface

- Initial user interface will be developed from java packages
- The Interface Contains required User Inputs for the Generating algorithm.
- Creating an interactive Graph Based real time GUI Generation.
- Developing the connectivity of the rooms from GUI.

8.2 Data Processing

- Inputs received from the user are No. of rooms, Connectivity of rooms and Area of the land (where the building will be placed).
- From No. of rooms generation of limited node creation logic will be processed.
- From Area of land generation of limited room placement area will be defined.
- From the connectivity Created by the user the generations of the rooms will be interconnected by the algorithm
- There Will be calculation of the fitness score from the generated outcomes

8.3 Optimum House Plan

- The method of analyzing an iteration as an equal and evolutionary strategy to induce the importance of the field of the floor plan generation.
- Every room in the structure is in a way accessed from any type of room in the structure via a hallway. It means that when the whole communication is linked and there will not be a single hallway structure being joined with all rooms
- To make it optimum Generation will be repeated for certain period of time to get an expected and optimum result

8.4 Generation of Structure.

- 2D floor plan representation includes information on room geometry and its type identified by the category colour. In addition, the location of doors and windows is present.
- Generated solutions can be previewed by moving the slider button. Each layout represents a solution that is a different from each other and satisfy design requirements.

CHAPTER-9

9 IMPLEMENTATION AND RESULT

- There is a furnished view for all the plans just to give a better idea to the users how the room would look with appropriate furniture in them and also the connectivity between rooms is based on the placement of the biggest room and rest of the room is built around them and hence it strictly sticks to the user needs and requirements.
- These layouts are better than hard blueprint layouts because it has furnished 2D view as well which would give the users a clear look onto their future dream house
- The user can ask for infinite combination of plans until they are satisfied with a single plan**.**
- There is Score GUI which shows the score of the fitness function which we have been implemented in our code.The higher the score better the generations.
- Further we also added certain limitations to the amount of size given by the user so that generating house will has stable build which has stronger foundation
- We have two approaches for our problem one:

Approach 1:

Usign binary Classification and segementing each rooms from the given space which was taken as the input from the user.This avoids unnecessary space which will generate as part of fitness function.Gives perfect shape and perfect connectivity to each room.That helps the generation algorithm to provide stable and attractive house plan.Cons of this approach is we have coded this is processing core which does not have good support 3D generation.For generation of 3D we have to take 2nd approach .

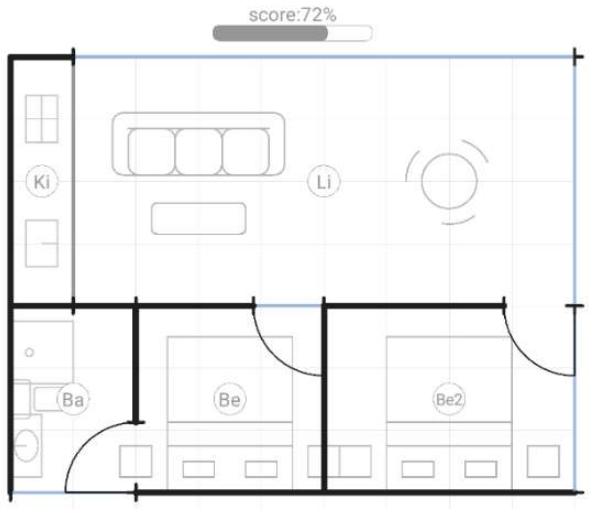

Fig 13: Generation of layout with 72% Score

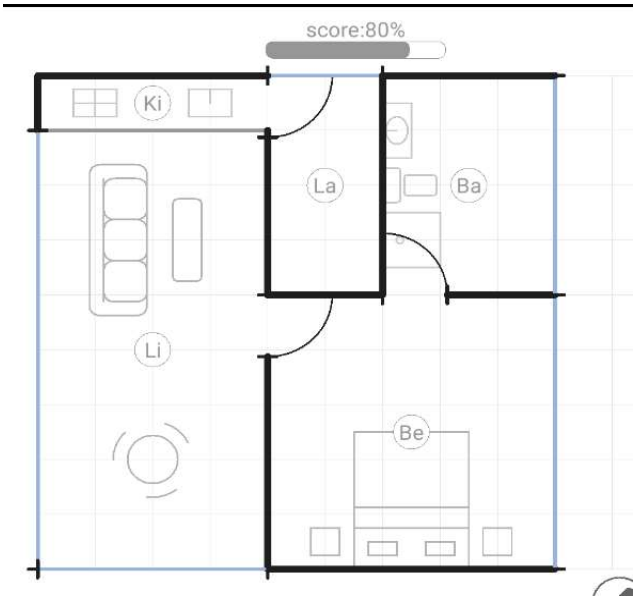

Fig 14: Generation of Layout with 80% Score

- **Approach 2:**

  For Generation of 3D floor plan we use Unity instead of processing core.Which helps us to build better GUI for everything.Since Binary Classification approach does not works perfectly on 3D generation.So we have Create some logic to eliminate the unnecessary spaces.Then We also added logic for creating Windows by asking the user for the direction of each rooms.Other Fitness Fuctions are all Same as First Approch.Below Were the Screen shot of outputs

Fig 15: 3D generation Side View

Fig 16: 3D Generation Top View

Fig 17: 3D Generation Front View

CHAPTER – 10

Conclusion and Future Work

Our idea is to create an application and that is cost effective and provide an easy-to-use interface for house floor plan design with less help of an engineer. Genetic algorithms leveraging randomization and constrain satisfaction techniques are employed to develop various optimal floor plans for the given land dimension. To the best of our knowledge, such a AI assisted software for floor plan generation is scarce in the literature. A very interesting domain to explore in further research would be to alter how databases determine fitness values for the genetic algorithm. Incorporating more complex data analysis systems could lead to better generated results. Methods such as cluster analysis could identify subgroups within a database and could lead to better identification of traits that are consistent within a cluster. An office called Micro Housing Solutions proposes a similar automation approach to structural consultancy, and has been working for some years in informal settlements in India. If structural parameters and economic parameters are added, a more robust system could be built. By giving a robust construction-plan software to typical users, many could dramatically improve their construction conditions. The general objective of this project is to rethink AI in a architectural domain. The software will further be extended to render 3-D designs for the house plans.With more accurate Structures and adding more data from different country so that generated house will have some culture to it according to user needs.

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