Application of parametric components in architectural planning

Wong Leong Yee

Faculty of Architecture, Department of Civil Engineering, Tamkang University, Taiwan

wleongyee@gmail.com

Abstract. The purpose of research is to experiment the use of grasshopper parametric software to analyze a rural district in Taiwan working as planning optimization tools for an aging population community. Conducting an architecture analysis is a process of work mainly dealing with data, as site information getting more complex it is no longer effective carried out by conventional method. Four sets of methodology are performed: (1) Spatial connectivity via road system, (2) path optimization, (3) location optimization for coverage area, and (4) land parcel classification grouping. The experimented results explore a data driven methodology of pre-design analysis in consideration of site context along with residence behavioral aspect, producing a more inclusive investigation for design solution.

Keywords: Parametric tools, site analysis, site planning

1. Introduction

“Technology is the answer, but what is the question?” by referencing the quote from Cedric Price inspire the intention to explore what can architectural planning benefit more from this technology flourishment era. Looking at the pre-design stage, site analysis is carried out to collect information from the soft data (variable measurement such as climate, community sociology and etc.), and also the hard data (permanent physical object containing topography, buildings, road system and etc.). Creating a set of all-covered analysis sometimes results a complex data which difficult to digest for design process. Moreover, the variable aspect collected could not perform instant simulation along with changes when it is presented on a sheet of paper list, which then makes site analysis a more visual aesthetic presentation rather than information driven approach.

Urban dense population issues are attempted to find its solution by numbers of data expert via using algorithm method, articles written available such as “Automated Space Allocation Using Mathematical Techniques” and “Approach to the Multi-Level Space Allocation Problem in Architecture Using a Hybrid Evolutionary Technique” focus on simulating the efficiency residential building for accommodation. Space Allocation process experiment the mix and match of input (habitant) based on specific criteria and ratio in a parameter, which then allows simulation for ideal settings. Using the same ideology of parametric system, the research attempts to apply into a rural community integrating with social and economics aspect in targeting aging community.
2. Literature review
In today’s advance period of map technology, information beyond geographical aspect such as scene information emerges along with maps, broadening the type of information to cater users need. GIS (Geographical Information System) is one of the tools born under the technological revolution which are widely used in all sectors. Application of GIS in architectural planning provides detailed mapping information that saves a lot of effort in analysis works. In an condition dealing with urban context, the consideration of analysis is more significant as most of the infrastructure is existed, furthermore, the complex subdivision of building plots making zoning and land-used identification a massive amount of works to be carry out. As it is shown how GIS plays a role in architecture field, much 3D modelling software starting to integrate this tool into their system to enhance design process. Plugin such as Meerkat GIS, Heron, and Gismo are written in grasshopper (Rhinoceros 3D parametric tool) as GIS platform for parametric modeling, which makes it as essential tools to be utilized in academia and industries.

3. Methodology
The research conducted specifically in two rural villages at Sanzhi District, Taiwan. It is also one of the districts that having circumstances of aging population, old ages has outnumbered the young due to nation low fertility rate, migration of the youngster into cities for better jobs opportunities simultaneously contribute to the condition. The observed villages have high possibility in turning into a ‘ghost town’ in 10 to 20 years of time. The researched outcome could provide an analysis base on geographical factors, residences settlement, and social behavior for design planning optimization.

The main source of activity for economy at the villages is agriculture, which had also influencing the social lifestyle of the communities that mostly happen from routine farming, this makes ‘population aging’ a big impact toward the communities as it reduce social interaction among each other’s, further cut down local source of income.

Residential settlement in the area is also much determined by agriculture activities where buildings are sited on irregular and scattered land plot, this created low neighborhood connectivity from one place another. ‘Population aging’ affects their walkability which also contribute to deterioration social interaction, in addition, road infrastructure in rural is far less efficient compare to the cities which make elderly prefer to stay at home.

3.1. Spatial connectivity via road system
This set of parametric components identifies the connected route from community center (blue circle) to residence preferable gathering spots (red circle) in shortest path. In the situation of low walkability of elderly physique makes activity area shrink closer to their home, hence further away from the community center. Data from the field also shows that the walking distance of elderly (based on various health condition) from home to community center is no longer relevant. The parametric outcome works as a guideline to reconnect both spaces in a more active way by approaching to the elderly, one of the examples could be decentralizing the community center into smaller station based on the frequent used route (shows in darker color).
Figure 1: Model of spatial connectivity via road system, various walkability distances based on health condition, and walkability comfort distance based on various locations.

3.2. Path optimization
This set of parametric components picks a random residential unit to identify the shortest route from a specific location spot, along with generating the time estimated for approach according to various form of transport. Medical facilities are a major concern especially in an aged population area, the discontinuous road system is commonly found in rural and agriculture area makes path finding a difficult task especially during emergencies. These outcomes could be further developed to perform as location optimization for service station to cover every residential unit for providing services in shortest time.

Figure 2: Model of path optimization with travel distance based on various transportation.
3.3. Location optimization for coverage radius
This set of parametric components identifies the coverage radius in targeted spots, temple is the selected as it has large compound area which all has in common, the compound would be activities ground for the community. The model works as finding the uncovered unit to be then reconnect within. Coverage radius was based on sound transmission in referring garbage truck alert music of 70dB, due to the low approachability road system, walking distance will not be considered.

Figure 3: Model of location optimization radius based on sound coverage of 70db.

3.4. Land parcel classification grouping
These both parametric components processes and identify the data of land parcel based on boundary, area size and neighboring parcel. As the parcel pattern in the villages are divided irregularly making difficult to identify the relation with neighboring plots manually. The first model indicate the parcel of agriculture land close to residential boundary (light green) to be used as elderly friendly farming system, simultaneously works as local-consuming production for the villages. Meanwhile the others away from residential boundary parcel (dark green) could be merged and rent for commercial agriculture.
The next model experimented drone driven agriculture system by selecting the smallest land parcel, which are then to be group within an allowed flying range radius to determine the control center location.

Figure 4: Model of land parcel classification grouping closest to residential boundary

Figure 5: Model of land parcel classification grouping based on land area within 3000sqm.
4. Conclusion and Discussion
In this research conducted, parametric tools works as a mediator to connect the relations between architectural aspect with economic and sociology that shapes the communities. Grasshopper parametric component allows flexibility in picking random selected location in model (1) and (2) for calculating distance to generate the time needed in approaching, simultaneously merge the generated path pattern in model (2) to maps the frequent used route that works as a potential location proposal. In model (3), parametric components ease the identification of units within adjustable coverage. In model (4), the output instantly performs identification on irregular plot upon smallest plots and nearest plots command. In future researches that expand coverage to others area, the system can be manipulate by adding more inputs like population, road pattern, land plot and etc., constructing a greater network of regional relationship from villages to district and so on.

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