TOWARDS A DIGITAL REPRESENTATION OF VERNACULAR ARCHITECTURE – THE TRADITIONAL MALAY HOUSES IN PERSPECTIVE

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Abstract. This paper focuses on an effort to represent the form and style of the traditional Malay houses (TMH) in a digital form to enable proper coding and compilation of the various built forms in a computing environment. In order to develop the data structure to code the form and styles of the houses, the scope of the study is currently limited to the original TMH of the *bumbung panjang* (long roof) type in which the key features of the houses were easily discernible from the side view. The digital representations of the houses are in the form of a database of construction elements with construction and addition rules to recreate the style of all the various *bumbung panjang* built forms. With this systematic programming approach, a digital representation of the traditional Malay house could be recalled and created within seconds.

1. Introduction

The traditional Malay houses (TMH) are located within the peninsular of Malaysia and are a form of local indigenous vernacular architecture. The houses provided a glimpse of the life of the Malays in the 19th century. The houses were built by master carpenters and builders. Due to the wooden materials used in the construction of these houses, many are no longer usable and some have been left unattended. Many efforts were made to document these houses by architects and enthusiasts as well as to preserve the houses that represent the local cultural heritage. The focus in the literature work was concentrated in documenting the built forms of the houses that includes the construction methods, the built-environment analysis, and ordering principles (Wan Burhanuddin, 1981; Kamaruddin, 1983; Nasir, 1985; Yuan, 1987; Gibbs, 1987; Raja Bahrin Shah, 1988; Esmawi, 1993; Nasir and Wan Teh, 1994; Syed Iskandar, 2001).

The construction of the TMH has been influenced by the iterative adoptions to local conditions such as religion, climate and materials. Within the Peninsular of Malaysia, there exist three distinct regions - northern, central and eastern, in which the TMH differs in styles. However, since the regions are subjected to almost similar local conditions, it is therefore not surprising to find the similarity of shape in most of these houses. This paper attempts to represent the form and style of the TMH in a digital form

to enable proper coding and compilation of the various built forms in a computing environment. In order to develop the data structure to code the form and styles of the houses, the scope of the study is currently limited to the original TMH of the *bumbung panjang* type in which the key features of the houses were easily discernible from the side view due to the high-pitched, gabled roof.

2. Related work

There has been a recent interest in the reconstruction of ancient or vernacular architecture in a digital environment (Liu et al. 2005, Li et al. 2005, Müller et al. 2005). This interest can be partly attributed to the availability of high computing power at a lower cost as well as the interest in the preservation of cultural heritages. Liu et al. (2005) modelled the ancient Chinese timber-structure building in the early Tang-Dynasty in Hong Kong. Their research aims to provide effective methods to preservation of ancient timber-structure buildings as well as a way of managing preservation projects. Li et al. (2005) on the other hand modelled the ancient Chinese architecture based on the construction constraints illuminated in the book *Yingzao fashi*. Müller et al. (2005) combined GIS (Geographical Information Systems) data with shape grammar rules derived from historical information to efficiently create detailed large scale Roman housing architecture.

Another facet to this interest is the development of pictorial generation theory that enables shapes and images to be analysed in a systematic way. An example of this is the shape grammar analysis that can be used to study an existing design and to generate new designs based on the design grammar rules. A shape grammar consists of a vocabulary of shapes (with or without labels), a set of shape rules, and an initial shape. The rules are presented as transformations of a shape or collection of shapes to a new shape or collection of shapes. Applied recursively on an initial shape, the rules produce designs that are said to belong to a language. The benefits of shape grammars over other language mediums when analysing and communicating the design of forms, are that they facilitate exploring the generation of other designs with the same style or convention (Stiny, 1980). Some examples of shape grammars applied to historical built forms are the *Palladian Villa* Grammar (Stiny and Mitchell, 1978), the *Mughul* Garden Grammar (Stiny and Mitchell, 1980), the African homesteads grammar (Herbert et. al 1994), the Taiwanese vernacular dwellings (Chiou and Krishnamurti, 1995), the traditional Turkish houses grammar (Cagdas, 1996) and the *Yingzao fashi* grammar (Li, 2001).

3. Descriptions of a Traditional Malay House

The TMH is comprised of the physical, spatial and functional elements. The functional element consists of a list of activities that may take place within the spaces of the houses that include receiving of guests, cooking, dining and sleeping. These activities are closely tied to the spatial elements because of the culture and tradition of the Malays. The inter-relationship of these

elements forms rules that determine the hierarchy of spatial importance in the TMH. The spatial element consists of spaces that form the TMH.

In the physical elements, a key feature of the TMH is the roof structure which is made up of two timber post and beam structures, supporting a high-pitched, gabled roof called the *bumbung panjang* (Figure 1).

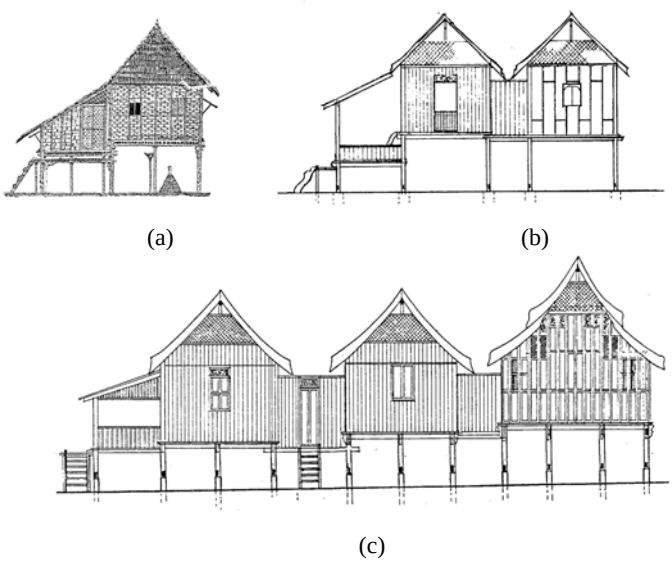


Figure 1. Examples of (a) 1-unit, (b) 2-unit and (c) 3-unit traditional Malay houses (adapted from Nasir, 1985).

The *bumbung panjang* features were accepted by researchers as the original form of the TMH that were not affected by any colonial influence. The *rumah ibu* (mother house) occupies the space under the *bumbung panjang*. The *rumah ibu* is considered as the core area of the house with its floor level being the highest. Most of the activities conducted within this space are performed by the women. These include sleeping, sewing, praying, ironing, studying, and even feasting. Full length windows can be found at the front and back of the *rumah ibu*. The *rumah ibu* may exist entirely by itself and is considered as the most basic form of the traditional Malay house. The built form of this simple house has been documented (Raja Bahrin Shah, 1988). All other spaces may be added to the basic form based on implicit rules as practised by master carpenters and builders.

The *serambi samanaik* or *kelek anak* (a verandah attached to the rumah ibu on the same floor level and facing backward) could be constructed together with the *rumah ibu* as part of the nine-post structure and housed under the skillion roof that is attached to the *bumbung panjang*. The *rumah ibu* and the *serambi samanaik* are integrated functionally, spatially and structurally. The *serambi gantung* (a hanging verandah attached to the *rumah ibu* facing the front of the house) is slightly wider than the *serambi samanaik* and at a lower level to the *rumah ibu* (Gibbs, 1987). This place is used to entertain male guests. It is roofed under skillion roof attached to *bumbung panjang* on the other side of the *rumah ibu*, opposite of the *serambi samanaik* area.

4. Construction Parameters of Traditional Malay Houses

To enable fast generation of the skeleton of the TMH, a construction grammar is used. The construction grammar follows the approach of shape grammar. The details of the construction grammar for the TMH are presented in Said and Embi (2006). A shape grammar approach is used due to the fact that the shapes of TMH can be easily described using geometry. This approach resulted in the 9 basic shapes and the addition rules to generate all the possible styles of the *bumbung panjang* TMH.

The key elements used in the construction grammar are given in Table 1. Some of the key elements are illustrated in Figures 2 and 3. To create a 3-dimensional unit of the house, the generated structure is duplicated along the z-axis to make up the 2 x 3-, 3 x 3-, 4 x 3-, or 4 x 4-post structures. The space developments of the basic TMH are shown in Figure 4. The increase in spaces from left to right in Figure 4 typically depicts the need for additional spaces. However, the phases of addition of spaces would be dictated by the form constructed in the initial phase. Unit [IB] is the simplest form of the traditional Malay house and is sometime called the *rumah bujang* (bachelor house) while unit [SG+IB+KA] is the most common form of a single-unit traditional Malay house and is fully capable to function as a family house.

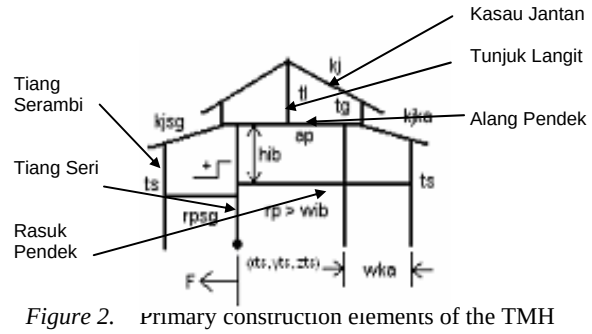


Figure 2. Primary construction elements of the TMH

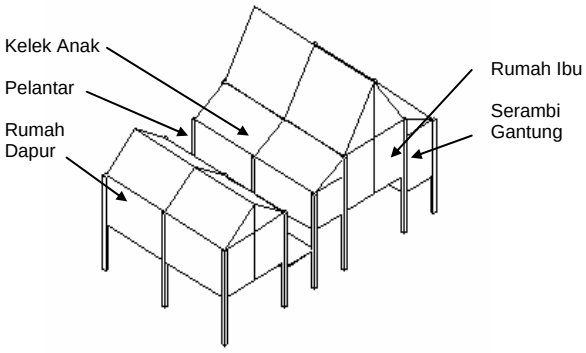


Figure 3. Primary spatial elements of the TMH

Additional units can be combined to the basic house unit to form a different TMH (see Figure 1(b) and (c)). The additional unit is called the *rumah dapur* (kitchen house) and its form is similar to the *rumah ibu*, i.e., the space is housed under the high-pitched, gabled roof. The *rumah dapur* is at a lower level then the *rumah ibu* and is situated at the back of the house, separated by a *selang* (an open platform).

TABLE 1. Primary elements of TMH.

Elements	Name	Symbol	Data	Notes*
Point	*tiang seri* location (main post)	lts	(x_{ts},y_{ts},z_{ts})	Ground level
	direction of the house	hdr	[i, j, k]	To front
	Posts' arrangement of each unit	par	$[n_w \times n_b]_{MN}$	Re. spatial elements
Linear -physical	*tiang seri* (main post)	tp	length, size start/end pt.	Size= 1 *ketak*^{2}
	rasuk pendek (short floor joist)	rp	as above	Size=1/3 *ketak*^{2}
	alang pendek (roof tie girt)	ap	as above	as above
	tiang serambi (verandah post)	ts	as above	Size= 1 *ketak*^{2}
	tiang gantung (hanging post)	tg	as above	Size=1/9 *ketak*^{2}
	tunjak langit (kingpost)	tl	as above	as above
	kasau jantan (rafter)	kj	as above	1/15 *ktk*^{2}
	angle of the main roof	θ (deg)	45-57	
	angle of skillion roof	θ (deg)	30-40	
	alang panjang (girt)	ag	length, size start/end pt.	Size=1/3 *ketak*^{2}
	rasuk panjang (floor beam)	rg	as above	as above
	tulang bumbung (roof ridge)	tb	as above	Size=1/9 *ketak*^{2}
Planar -physical	*dinding* (walls) with *tingkap* (windows) and *pintu* (doors)	di	Tiles arrangement	Re. tile elements
	tebar layar (gables ends)	ty	as above	as above
	atap (roofs)	at	as above	as above
Spatial	*rumah ibu* (mother house)	IB	Y/N	Re. style
	kelek anak or *serambi samanaik* (verandah)	KA	Y/N	as above
	serambi gantung (hanging verandah)	SG	Y/N	as above
	selasar (rear hanging verandah)	SL	Y/N	as above
	loteng (attic)	LG	Y/N	as above
	kolong (space beneath the floor)	KG	Y/N	as above
	Selang or pelantar (intermediary spaces)	SG/PL	Y/N	as above
	courtyard	CT	Y/N	as above
	anjung (verandah addition)	AJ	Y/N	as above
	rumah dapur (kitchen)	DP	Y/N	as above
	rumah tengah (middle house)	RT	Y/N	as above
	rumah tangga (stair house)	RG	Y/N	as above
	tangga (stairs)	TG	Y/N	as above
	jemuran (unroofed platform)	JR	Y/N	as above

* *Ketak* (or *ktk*) is the length between the first knuckle of the first finger and the tip of the thumb of an adult person.

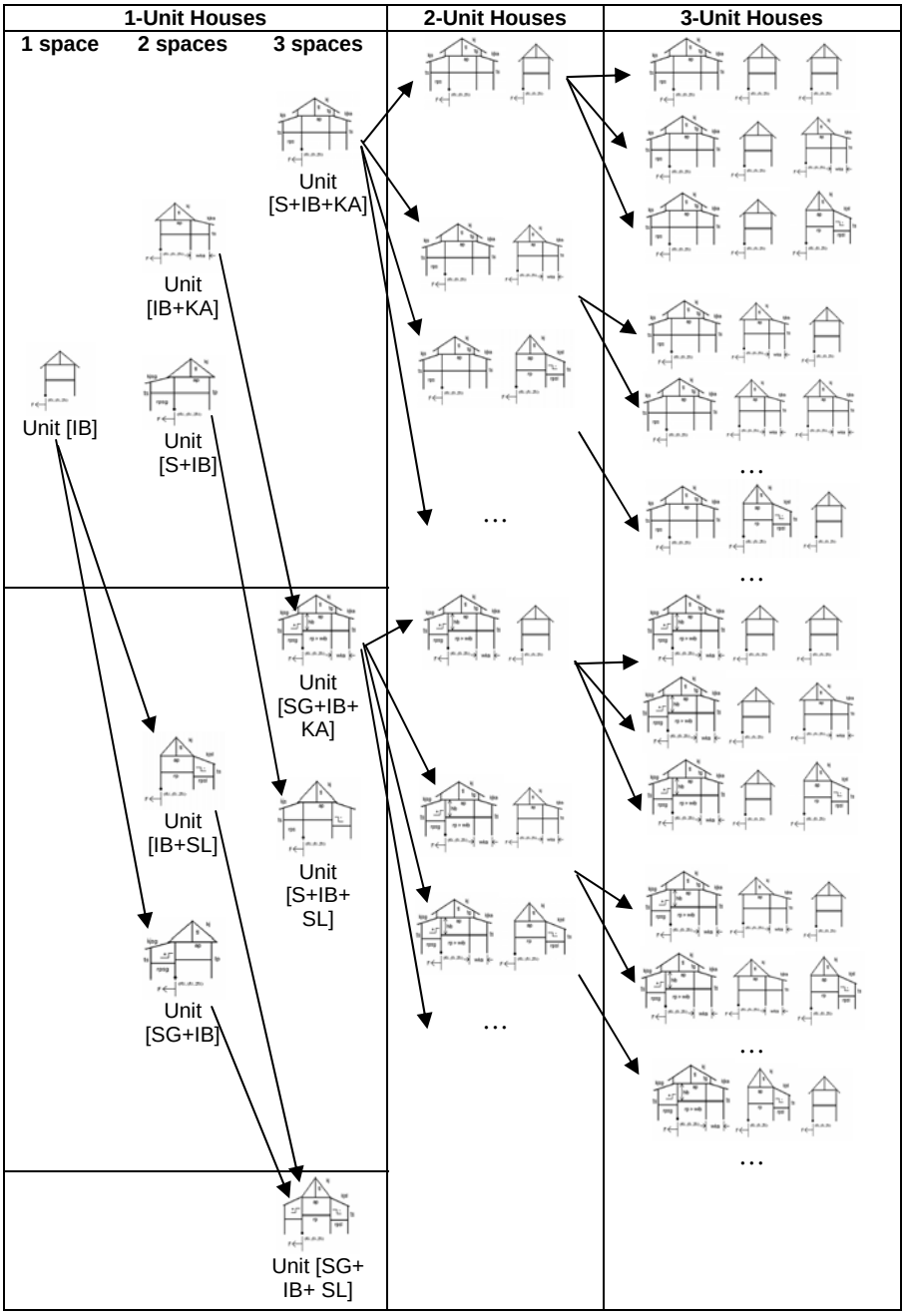


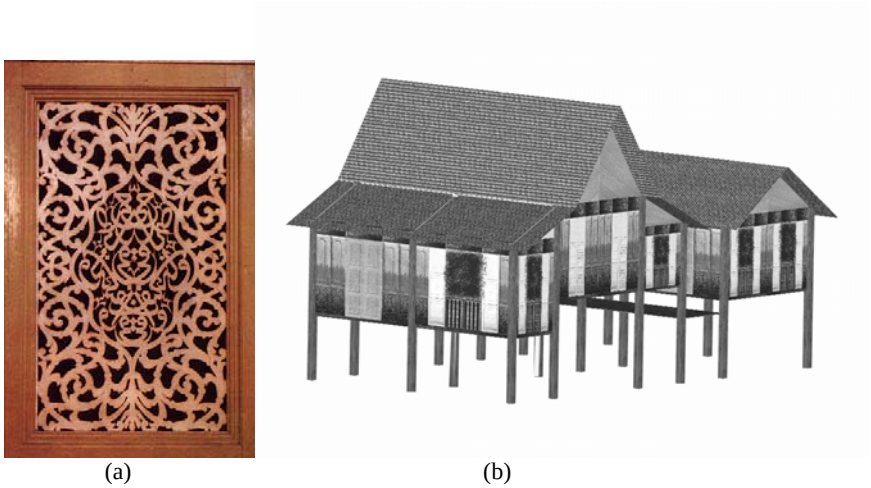
Figure 4. Some examples of 1-, 2- and 3-unit traditional Malay houses that can be generated.

Examples of multi-unit traditional Malay house formed by the combinations of the basic single units separated by a *selang* are shown in Figure 4. For the two-unit house, the additional space will form the *rumah dapur* or unit [DP]. In the three-unit house, the middle unit is called the *rumah tengah* (centre house) or unit [RT]. In terms of shape, units [DP] and [RT] are very similar to unit [IB]. They differ only in their dimensions and floor levels.

5. Digital modelling of TMH

Digital modelling of the TMH begins with generation of the structure using the construction grammar. A total of 9 structural forms representing the 9 basic units can be built as well as 27 structural forms representing the combination of the 9 basic units with 3 of the basic units that serve as the second unit. Up to 81 different structural form of a 3-unit TMH can be built by combining the 27 2-unit structural forms with 3 of the basic units that serve as the third unit. Thus, a total of 117 unique different skeleton structures of TMH can be generated. This represents the more popular forms of the TMH out of the 819 possible forms generated from the combinations of 1-unit, 2-unit and 3-unit structures.

Following the generation of the structural forms, the next task is to embellish the structure with ornamental details that have made TMH unique and famous. An example of a wall tile is shown in Figure 5(a). The roof tiles are attached to the roof elements during rendering process to create a realistic looking roof. Window and door tiles are attached to the wall elements by interspacing them with the wall tiles. Gable ends are attached with the suitable wall tiles. The visible columns are rendered with wooden materials. An example rendition of a 2-unit TMH is shown in Figure 5(b). All the above steps are implemented in AutoLISP within an AutoCAD environment. All the basic units of the TMH are built as parameterised blocks and the ornamental details are stored in bitmap form in rendering materials.



(a) (b)

Figure 5. (a) An example of a wall tile and (b) a rendered image of a particular TMH.

6. Conclusions

The digital reconstruction environment of TMH has been developed. At the moment, the authors are experimenting with all possible structures of the TMH using various ornamental details to recreate the best representation of the documented TMH. The almost unlimited combinations of the ornamental details will result in a unique TMH whenever one is generated. We are in the process of generating a scenario where the generated TMHs are placed within a simulated geographical environment to recreate a 19th

century village scene. We have yet to test the realism of this representation in a virtual environment. Further work is envisaged on this front once a user-friendly interface has been developed enabling novice users to easily use the application.

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