Science Arena Publications
Specialty Journal of Architecture and Construction
Available online at www.sciarena.com
2016, Vol 2 (3): 57-66

Evaluation of sky view factor under the pretext of urban geometry and a variable in comfort

Mehrangiz Piriyaei[1] , Sahar Khodabakhshi[2] , Hamidreza Saremi[3]
[1]Department of Architecture, Doroud Branch, Islamic Azad University, Doroud, Iran
[2]Young Researchers Club, khomein Branch, Islamic Azad University. khomein, Iran
sahar.khodabakhshi@hotmail.com
[3]Assistance Professor Department of Art and architecture, Tarbiat Modares University،Tehran, Iran

Abstract: *Today, while creating a new geometry as urban geometry that has significant effects on the environment and urban climate, it has been become a design approach by planner and architects to promote environment comfort quality and to satisfy members. The main characteristic of urban geometry is as variable as sky view factor that states geometrical shape of the surface.*
In this study, while introducing the sky view factor as a key factor in comfort and its relationship to the other factors affecting on the microclimate along with case study on houses of Yazd, we try to indicate how to use the sky view factor in the formation of climate architecture of Yazd. In research method part, we have restricted the scope of our studies to open spaces of residential houses to limit the scope of studies as well as reduce variables. In this study, cross-sectional descriptive research method has been used. The sky view factor was measured through spherical shooting by Rayman computing program. The obtained data, as well as information aboutthe structure, included length width, height comparable basis, and the sky view factor in structure.The results of comparing the analogy between building show that this factor is considered in the design of buildings and principles of designing spaces are in a defined range.
Keywords: *urban geometry, the sky view factor, thermal comfort, Yazd climate.*

1. INTRODUCTION

It is believed that comfort is affected by many variables. Many environmental and specific factors involve in the creation of it. Among these factors, urban density has a huge impact on the aerodynamics of urban (Oke, 1987). The urban levels create a complex structure in micro-scale. These patterns include variables such as radiative and thermal properties of surfaces, the amount of radiation received from adjacent surfaces, sky view factor, and shadow created by objects. The sky view factor is one of the main indicators of urban geometry resulting from urban heat islands (Eliasson, 1992). Many studies have been conducted on the sky view factor around the world that indicates the significant impact of this factor on urban climatology. Apart from a few studies, no study has been conducted in Iran. This study, while addressing this component and reviewing how to apply it in the traditional design emphasis on the important of the subject. The research method in this study is a case study on the open spaces of residential buildings in the city of Yazd. In this regard, along with selecting ten residential building, the sky view factor in these buildings has been examined. The sky view factor was measured through spherical photography by the camera with the fisheye lens while mining and calculating coefficients with Rayman computing program. In the following, the results are presented as a chart by Excel .

Corresponding author: Mehdi Yadollahi, Email address: Yadollahi.Mehdi.PNU@gmail.com

Definitions and background:

Research background:

A lot of research has been conducted in the field of urban geometry titled influence of "sky view factor" on urban climate (Oke 1987, Unger, 2004). Also, these components have been employed in a variety of new fields including modeling conditioning method, research into renewable energy source in nature (Richert, 2010). In addition to these studies, many efforts have been made in the development of measurement method of this variable (Oke, 1981: Steyn, 1980: Beker, 1989) that resulted in the formation of diverse practices in this field that include simulation and calculation software. Development of measurement methods and checking it as a key factor in climatic design is increasing-

1-2.Sky view factor

Sky view factor states the amount of radiation received from the hemisphere radiation on its surface (Watson, Johnson, 1987). The sky view factor is a dimensionless parameter between zero and a defined value(Oke, 1981). Various view factors mean the difference between incoming radiations. It is measured based on radiation amount and brightness of the sky. Its scope is based on sky position and received radiation amount. According to this factor range, 0 means you do not see the whole sky and 1 means complete openness the sky view. In summary, the low coefficient show less received radiation relative to places with higher sky view factor.

1-3. Impact of sky view factor on comfort

A lot of studies have been conducted in the fields of urban geometry and its impacts on urban climate. The studies were based on the relationship between urban density, length to width ratio and sky view factor with climate variable that shows these variables have an important role in urban climate (Oke, 1987). This parameter is applied as an important parameter in thermal modeling like urban heat island (Unger, 2004). Many studies conducted on sky view factor and its relationship with other climate variables show that there is a correlation and linear relationship between temperature and sky view factor (Eliasson, 1992: Unger, 2004). Among available studies, there is a significant relationship between sky view factor and mean radiant temperature. In a study conducted according to a field study on Tehran's garden relating thermal comfort of outdoor users, it is emphasized on the sky view factor and mean radiant temperature in the studied areas (MostafaBehzad Far, Ali Reza Menam, 1389). In another study conducted at the Ekbatan's residential complex on thermal comfort in Tehran, there is a significant relationship between sky view factor and physiological equivalent temperature in four seasons. Therefore, with increasing sky view factor, the reflection amount rises and consequently average physiologic temperature is reduced (Seyed Amir Said Mahmoodi, SeyedehNedaGhaziZadeh, AlirezaMenam 1389). The following figure shows the sky view factor with climate variables.

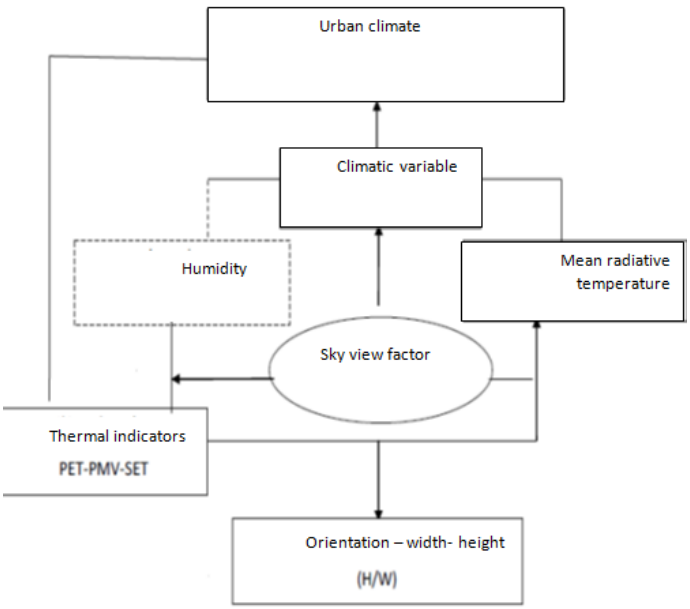

Figure 1: analyzing sky view factor in urban climatology (reference: author)

2-Research method

The method used in this study was a case study that was conducted along with selecting residential buildings in the city of Yazd based on analyzing open space of constructions. The survey of samples is based on observation and measurement in the courtyard of buildings. In this way, that sky view factor was analyzed by images of the camera with the ability to capture spherical shooting in the focal points and center of the building. The selected points for shooting near the center of views with a distance of 70 cm from walls in 5 points from the yard were calculated. In the next step, data obtained from images were compared with each other to obtain more documentary from sky view factor with another component including space and width to length ratio. Data were drawn as a chart by Excel.

2-1.field study

Yazd buildings are valuable structures that represent consciousness design principles that are right choices to assisting studies. The selected buildings include ten structures with the essence of organizing space with a central courtyard such as houses of Shokoogi, Arab Zadeh, NavabVakil, Lari ha, Olia, Lari ha at the university of Yazd, Gulshan complex consisting of two main courtyards, and Mahmoodi complex with two courtyards. The measurements were carried out on the main and large courtyard of buildings. The buildings placed on the old texture of Yazd in Fahadan area. The operations were carried out on three consecutive days, 1st to 3st Feb.

2-2.Data collection technique

Many studied were conducted to evaluate and calculate sky view factor. The first method is a simple geometric modeling method that was common in the 1980s (Oke, 1980: Jonson and Watson 1984). Recently, we have seen new simulation methods by software. In this method, the calculation is performed based on spherical pictures that are more accurate and can calculate sky view factor with high speed in urban climate. In this study, spherical photography is used to calculate sky view factor and Rayman software model is

employed to analyze data. Rayman model was designed by Dr. AnderiasMatazaraks (2004) for calculating radiative fluxes in urban climate. It can analyze the sky view factor. This model is available through a database of http://www/mif.uni-freiburg.de/rayman. In this method, sky view factor is calculated after quantifying the obstacles in the image during loading the model directly. After determining values, the number and value of sky view factor were evaluated while calculating the pixels of the sky. Finally, it is attributed to the total number of pixels. The input files are processable as Bitmap. The output value of sky view factor is displayed up to three decimal places.

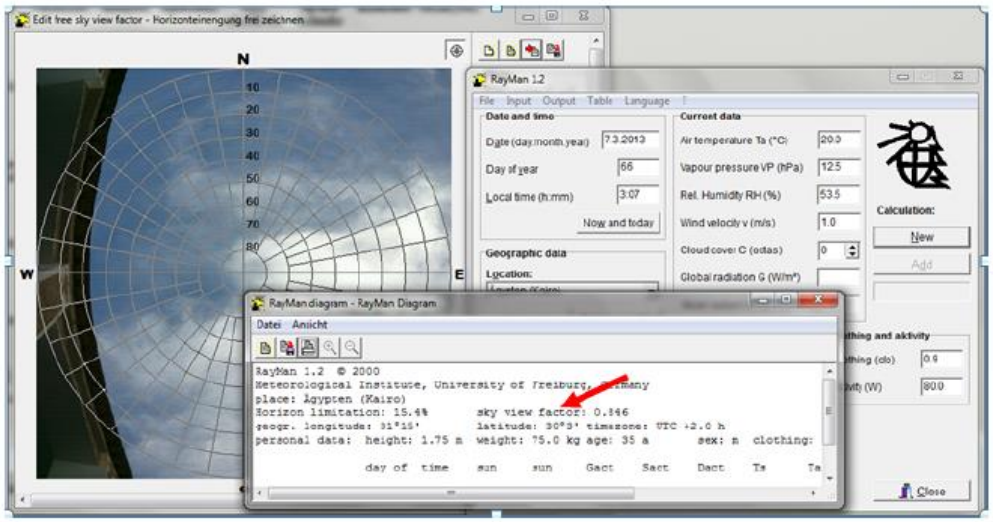

Figure 2: analyze spherical images by Rayman software (reference: author)

Spherical photography by Fish-eye lens with wide angle was carried out that have the ability to create 180-degree visibility. The camera used in this study had an 18-megapixel sensor with the FF8 lens. The shooting was performed on a tripod at a height of 20 cm from the ground. Studiesconducted on the height of shooting show that there is more correlation with climatic variables in the height close to the surface .

3-Field data

The shooting was performed in ten houses with spatial variation. Five spots were selected in the main axis in the center of the courtyard. The shooting was carried out with 4-5 intervals. Table 1 represents the information related to geometry, the evaluated spaces as the ratio of length to width, building height, and area of the yard.

samples	Sky view factor	Sky view factor	Building height (m)	Yard area (m)	Yard dimensions (m)	Width to length ratio of yards
Arab Zadeh's house	South view	0.794	7.15	307.43	12.19-25.22	2.6
	Other views	0.814	5.51			
Golshan 1 house	South view	0.796	7.33	280.6	19-14.77	1.28
	Other views	0.815	5.44			
Golshan 2 house	South view	0.797	7.23	250	15.6 -12	1.3
	Other views	0.815	5.40			
Lari's house-university	South view	0.819	5	135.2	14.4- 9.4	1.53
	Other views	0.819	5			
Lari ha houses	South view	0.756	10.5	679	33.8- 20.1	1.68
	Other views	0.698	7.15			
Mahmoodi 1 house	South view	0.796	7.33	400	24-16.7	1.43
	Other views	0.812	7.15			
Mahmoodi 2 house	South view	0.800	5.32	260	19 – 13.7	1.36
	Other views	0.816	5.3			
Navab's house	South view	0.816	5.3	195	11- 17.7	1.6
	Other views	0.816	5.3			
Olia's house	South view	0.819	5	172	14.7 – 11.7	1.25
	Other views	0.819	6.8			
Shokohi's house	South view	0.810	6.8	374	20.8 - 18	1.15
	Other views	0.815	5.36			

Table 1: the geometry of spaces (yards), in studied samples (reference: author)

Table 1 shows the values obtained from houses based on views. The domain resulted from sky view factor in houses was recorded between 0.756 and 0.819. The lowest value belongs to Lari ha' houses in south view with 10.5 height. Figure 4 shows the shooting place and analyze of extent and scope of fish-eye images in 5 points of the yard.

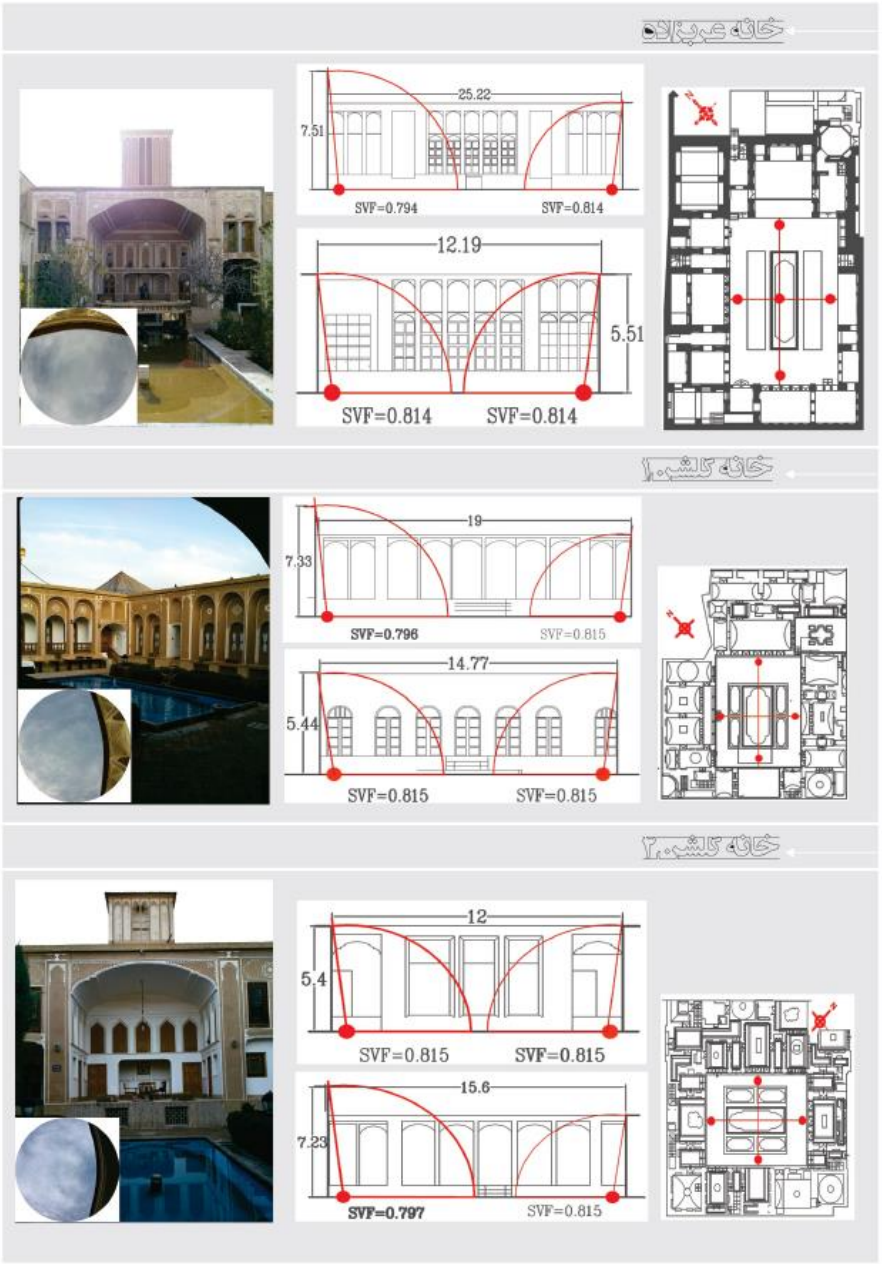

Figure 3: Fish-eye shooting place in studied houses (reference: author)

3-1.Comparing sky views factor in various views

Sky view factors were obtained in north, east, west and central views byRayman software. The obtained values were the same in three views including east, west and north views and were recorded with a different south view. Thus sky view factor in south view was obtained less than other views. This decreasing and closing sky view result from increasing height at this view. According to it is a summer view and is often in shadow and sky view factor this height increasing happened entirely conscious. It was obtained in the center of the yard according to the time of the shooting in winter and lack of vegetation as a wide open space and with a value of 0 for all buildings. The sky is completely open in the center of yard and radiation energy is complete in this place. The figure shows the obtained values of sky view factor in buildings with a separate view in the form of a chart.

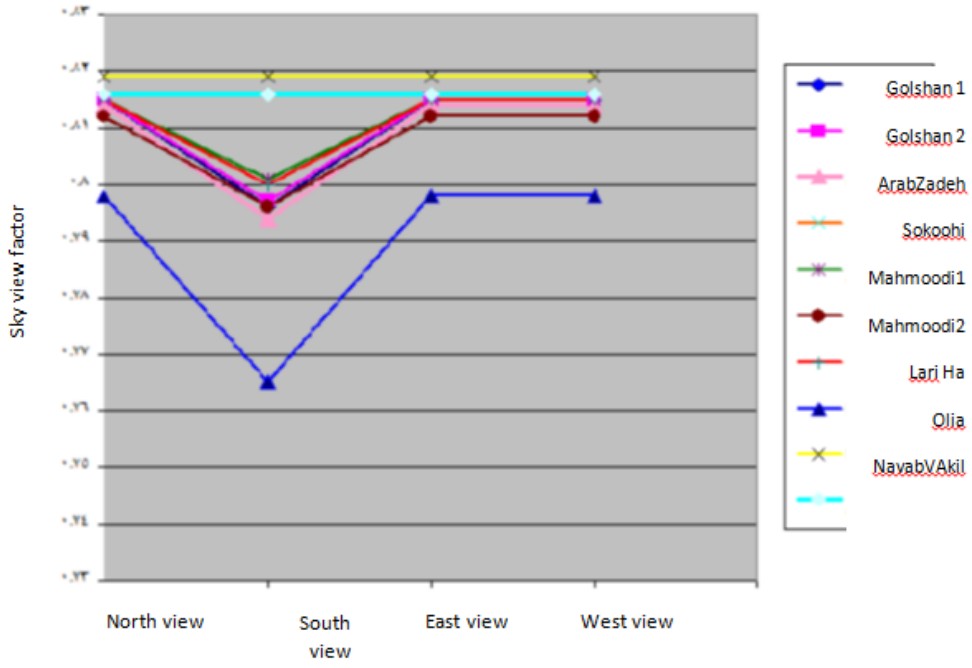

Figure 3: Comparing sky view factor in various views (reference: author)

3-2.Analyze the geometry of structures and comparing it with sky view factor

We observe changes in sky view factor in obtained data. This process seems logic by analyzing geometry and building structure. The proportions involve changes in the yard space openness. These variables include length, width, and height depending on various views. Thus with decreasing sky view factor in various views, the area amount is increased and vice-versa. In this study, with evaluating ten buildings, we observe a significant relationship between sky view factor and building geometry. Sky view factor was compared with structure area in figure 3.

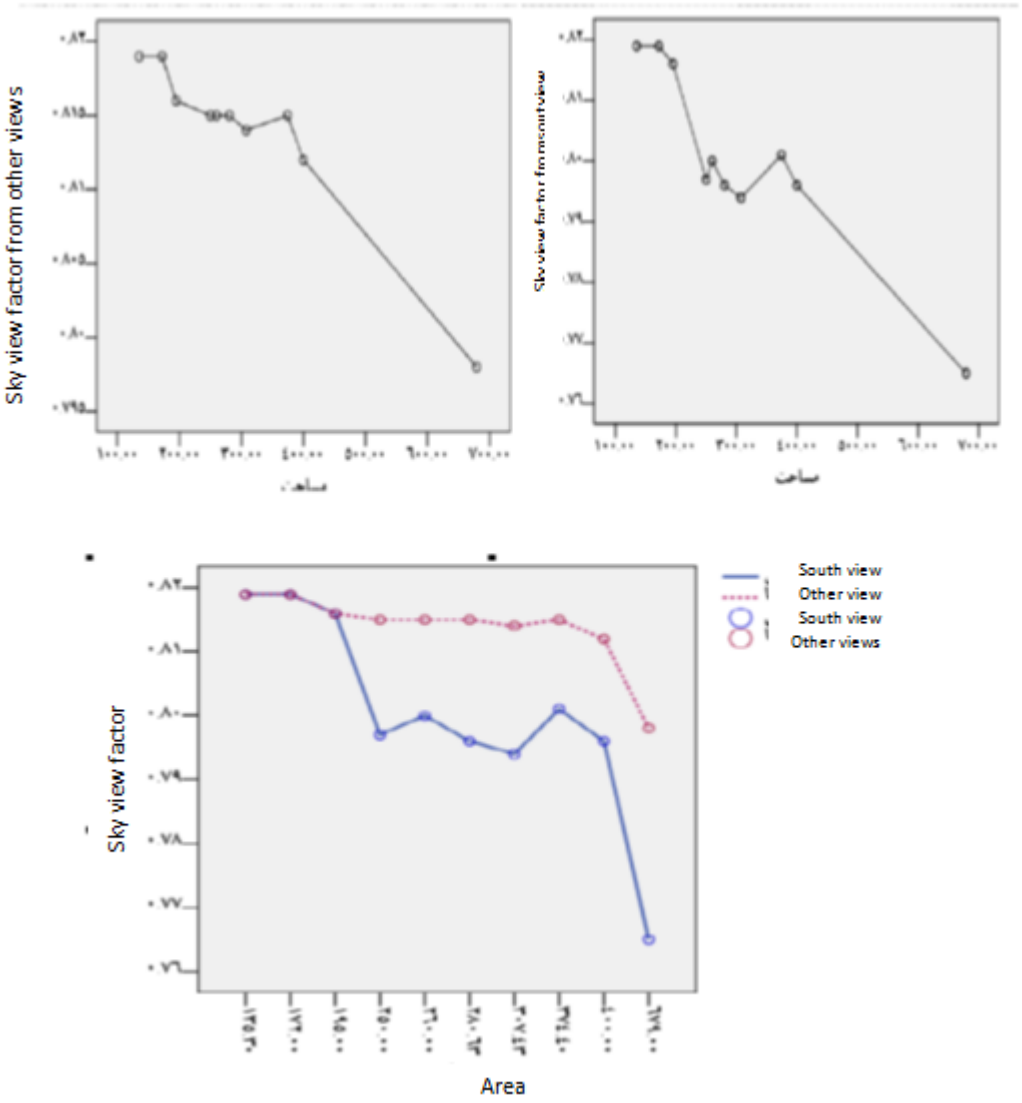

Figure 3: comparing sky view factor and building area that have an inverse relationship with each other (reference: author)

3-3.Analyze of image of sky view factor of view on the yard

In an evaluation with the imaging of sky view factor of view on building yard, we observe the general process of ductility of spaces in relation to sky view factor. Thus, the opening of yard space approximately results from the sum of the spherical image of views and dock area. This structure exists in all samples except Lari ha's yard located at the university of Yazd. The nature of the yard is different with other yards and it is likea garden pit. Figure 4 show the spherical photography of yards.

Pool area + spherical photography of views on the ground ≅ area of the yard at home

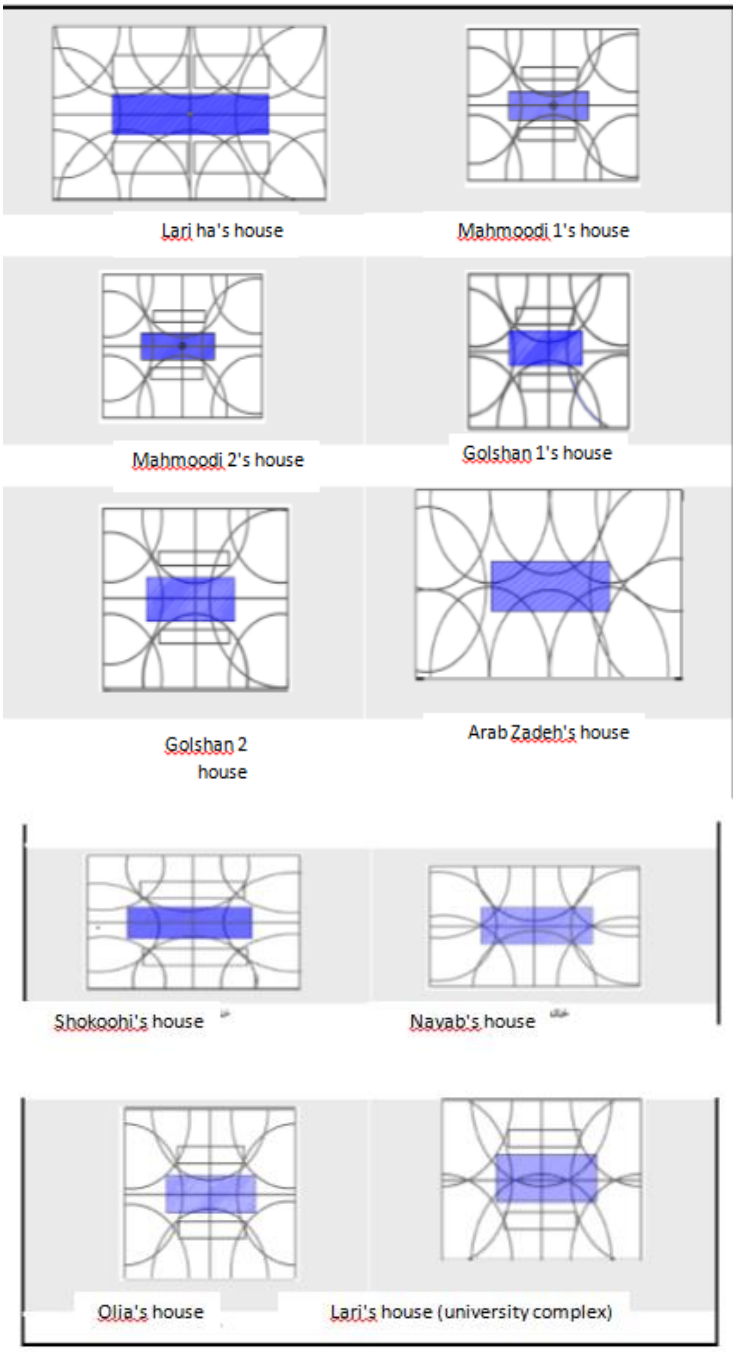

Figure 3: image of sky view factor (results from fish-eye images) in studied samples (reference: author)

As seen in figure 3, a module structure is considered as a critical factor in relation to sky view factor to control climatic factors. The design is performed such a way, radiation variables in the framework of this geometry are used in the best way. The efficiency of these views is so that it modifies the weather conditions during the hottest days of summer and coldest days of winter in this climate.

Conclusion:

While introducing sky view factor as an influencing climatic variable along with case study on Yazd's residential building,this study tries to show how to apply sky view factor component in the formation of Yazd's climatic architecture. The selected building has a spatial structure with desert climate characteristic with evaluating sky view factor in the inner courtyard of the building sky view factor was obtained through spherical shooting nearing views. Rayman software was used to calculate it. The values obtained from photography of all buildings is in the range of 0.698 with at least sky view factor for Lari ha' house and is in the range of 0.819 with the most sky view factor for OliaValari's house (in university complex). The changes relate linearly with yards area. During the survey, we observe a decrease in sky view factor in south view and summery side. It is due to a lower request of this view of radiative energy. In the study process, while imaging sky view factor of views on yard spaces, thedimension of yard considered larger than enclosed space by sky view factor of views. Thus yard openness resulted from the front area of the spherical including dock area.

Dock area+ spherical image area on the ground ≅ area of the yard at home

Finally, given the importance of this indicator as a climatic variable thatcan be controlled by designers, it should be acknowledgedthat achieve a rapid method to verify knowledge and calculate sky view factor of urban spaces in order to adjust thermal comfort.

References:

1. Menam, Ali Reza (2010), sky view factor influence on thermal comfort of urban space users, beautiful arts, p 23-34.
2. Mahmoodi, Seyed Amir Said Mahmoodi, Ghazi Zadeh, SeyedehNeda Ghazi Zadeh, Menam , Alireza (2010), the impact of design on thermal comfort of residential complex outdoor, journal of Fine Arts, No 59, p 42-70.
3. Becker, P., Erhart, D. W. & Smith, A. P. (1989) 'Analysis of Forest Light Environments Part Computerized Estimation of Solar Radiation from Hemispherical Canopy Photographs',"Agricultural and Forest Meteorology", 44: 217-232
4. Eliasson, I. (1992) 'Infrared Thermography and Urban Temperature Patterns', "International Journal of Remote Sensing".13:869-879
5. OkeTR(1981)Canyon geometry and the nocturnal urban hate island:comparison of scale mode and fiel observation.JClimatol1:237:245
6. OkeTr(1987) Boundary layer climates.Methen,Londan RattiC ,Richens P (1999)urbntureanali*tex
7. Richert C(2010)GIS-gestutzteAnalyse des klimatischen potentials der Windenergie in der Rigion Freiburg imBresigau auf der grundlage von MagisterScicntiarum Thesis, unpublished..Supervisors:Prof.Dr.Rudiger Glaser (Departmantof physical Geography),prof.Dr:AndreasMatazarakis (Meteorological Institute),Abert-Ludwigs-Unversity ofFreburg
8. Steyn, D.G. (1980) 'The Calculation of View Factors from Fisheye-Lens Photograp "Atmosphere-Ocean": 254-258.
9. Unger, Janos (2004) 'Intra-Urban Relationship between Surface Geometry and Urban Heat WAatson,I.D&Johason 253–264 , -27:Island: Review and New Approach', "Climatic Research", Enviroments."International G.I.)1987)'Graphical Estimation of Sky View-Factors in Urban