Using Isovist Application to Explore Visibility Area of Hospital Inpatient Ward

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Abstract. This paper reports an on-going project that explores the use of digital application to study human field of view. The focus of discussion is to study the patients' visual experience, in relation to the arrangement of interior elements in patients' ward. The physical qualities of the environment can influence the healing process of the patient. Typical layout of interior elements often fails to provide visual stimulus that could support the healing process of the. This study explores the experience of seeing by simulating the hospital ward setting into 3D model using isovist analysis. Isovist is used to represent the experience of seeing by the patient from particular point of view and also to represent the object and surfaces that are being seen. Isovist has a function to show us the boundary of the visible areas, which can reveal which elements can and cannot seen by the patient. Isovist provides a way to understand the experience of seeing and being seen by visualizing the visibility area through three dimensional modelling. This study suggests the possibility to study human field of view to support the design of architecture for health.

1. Introduction

The purpose of this study is to explore visibility area of hospital inpatient ward through isovist application. Visibility area becomes important in healthcare architecture, since many research revealed the effect of viewing to patients health condition. Ulrich emphasized that seeing experience may influence patients recovery [1]. He discussed the limitation in hospital to give visual access for the patients [1]. Access to seeing experience is a way to provide visual information which could stimulate attention from the patient

In general the design guidance for healthcare buildings already suggested the importance of visual access for patient. This includes the views out of the building, design to give people contact with nature, finishes that provide a variety of colours and texture, art to provide stimulation and distraction, and interior appereance design to inspire confidence and positive atmosphere [2]. However there is a question of how the patients experience the activity of seeing, and how the environment of the spatient plays a role in providing visual information from the arrangement of interior elements.

There are many methods to analysis the visual information in an environment such as isovist approach. Isovist has been used for various purposes of application in various fields including in studying the perception of space which is in the intersection between the fields of psychology and architecture. Benedikt explained the relevance of isovist to architecture and isovist "as a collection of visible area real surface in space" [3]. He also described an isovist as "the set of all points visible form

a given vantage point in space" [3]. Turner denoted isovist as "a viewshed or an area in spatial environment directly visible from a location within the space" [4]. Batty explained isovist as "the space that can be seen from any vantage point" [5].

Some research have used isovist as a visual analytical tool to explore the visibility area. For example; to study the pattern of connections for a simple spatial configuration [4]. and to study the visibility degree of spatial configuration [6]. This research attempts to examine the negative and positive space experienced visually through isovist 3D model, which indicates the seeing experience created by the arrangement of interior elements in the patients' ward in the hospital.

Isovist approach could reveal that human field of view can be represented in particular shapes. The shapes of human field of view indicate what is detectable by the viewpoint in a visual medium from one point and represent their geometric properties. Isovist can be used to visualize the visibility area represented through a graph of visibility area in geometric features. Therefore, it needs the data of spatial and human field of view to determine the boundary of the visibility area.

Human field of view can be known by exploring vision experience through vision mechanism. Gibson defined the term field of view as a viewpoint that occurs from the reflection of light which is visible to the eye [7]. The field of view has a boundary that defines certain large visual area. The angular area of the field of view depends on the position of eyes, head and body in the medium of vision. The essential elements of human field of view are its boundaries, both obscure and boundless boundaries. These boundaries differentiated the visible area from the invisible area. Essentially, the field of view indicates whatever the visual world presents to the observer and detectable to the eyes through the field of view

2. The Role of Human Field of View in Experiencing Space

The experience of seeing and being seen is intertwined and play a role as a part of psychoneuroimmunology, in which psychic, mind and body had interplay with the environment as a part in the whole of human wellbeing [8]. Trevelyan explain "seeing as experiencing" as a spatial experience through visual experience [9]. Eye movement traces elements of space, from the plane of the wall, to a pillar and then to the column and into the wall above the opening and then to the openings Visual experience brings the patient from one image to another image that together bring the views of life.

"Seeing as healing" occurs when the experience of seeing can influence recovery process through the response of the patients' sensory that have been triggered or controlled by the spatial elements in the environment [10]. Investigation of the patients' responses to visual environment such as views of natural scene, art products, and plasma windows has shown a strong effect such as reducing fear and stress, replacing with positive distraction, holding interest, evoking positive feelings and curiousity [11]. A study by Ulrich found that patients in pain and suffering condition in patient's room with natural window tend to heal in shorter time, have fewer complaints and have lower level of minor complication after surgery. In addition, he also found the different conditions of patients with wall-view in the ward compared to those with the tree-view [12].
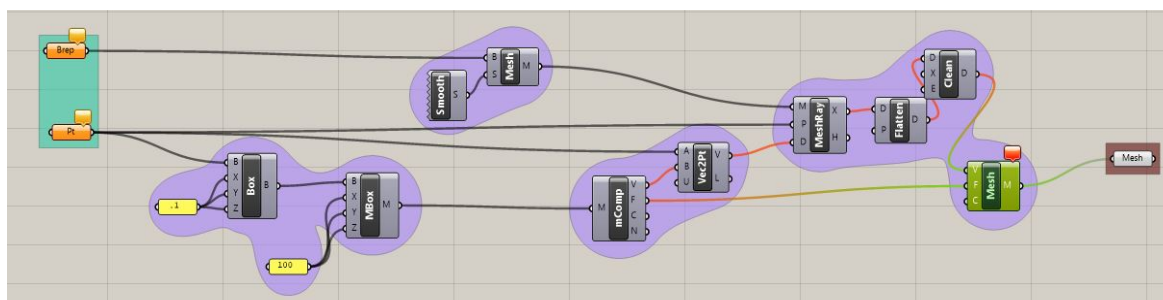
This paper explores both the mechanism of seeing and being seen as experienced by patients in healthcare environment. In the mechanism of seeing, human field of view involved the eye structures such as focus function view (fovea vision) and the spread of the focal point of the view (peripheral vision) that create the visual range (field of view) [13][14][15]. Gibson explained that human field of view is influenced by the position of the observer, which shows the existence of the self and the motion of the body [7]. In the mechanism of seeing, isovist is used to analyze the visual angle which includes the position of human field of view.

Environment as being seen takes a role as stimulus by providing information through the reflection of light on the surface that humans can respond. In this process, the transactions happens through information provision and information reception. The surface could be visible if there is a light source and if it has the ability to reflect light [7]. In the mechanism of being seen, isovist is used to record the surface through the advantage point in the medium of vision.
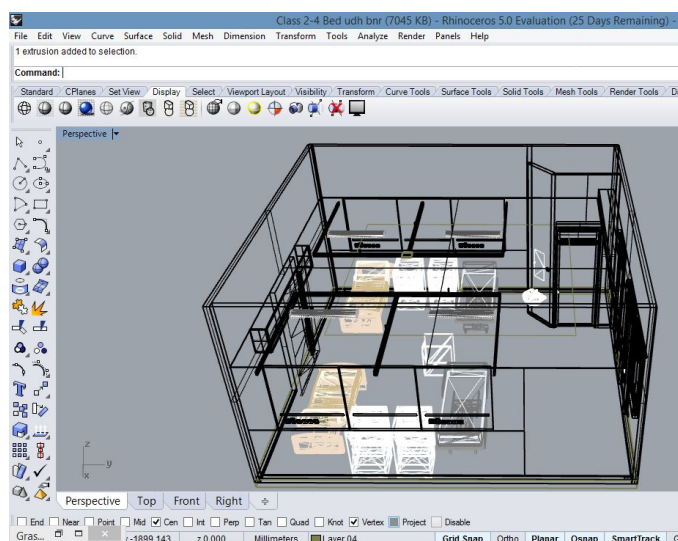
3. Methods

This study used a single isovist method to explore the mechanism of seeing and being seen. The method was applied by using three-dimensional modeling program Rhinoceros which is supported by the graphics algorithm of Grasshopper. Digital modeling was used to represent the existing condition of the patient's room in reality. The isovist approach was applied to reveal which elements can be seen by the patient in a lying position and also to find the characters of the boundary of visibility area model.

The study was performed on a set of virtual indoor scenes of hospital ward setting as the stimuli of human visual of field. The scenes represented spatial situations in an inpatient ward which contains four patient beds, cabinet, curtain, and some medical equipment. This study applied two methods to represent the stimuli for human field of view. The first is by using the camera viewpoint in 3d model created in Rhinoceros. Angles of view indicate different directions of the neck, head and eye movement. Every sections are modelled based on the direction of y or z-axis. The direction of y-axis shows the motion of viewpoint from buttom to the top view. The viewpoint based on the z-axis shows the motion of viewpoint from left to the right view. By using this method it is possible to register a series of visual scenes as a simulation of the way patients view their environment.

Figure 1. 3D Isovist formula in Grasshopper [16].

The second method is by using isovist application in three dimensional modelling with Rhinoceros with Grasshopper plug-in. The 3D isovist formula in Figure 1 which is used in this method was adapted from Heumann and then applied in the model in Figure 2 which is created in 3D model Rhinoceros that represents the actual condition of inpatient ward in hospital [16].

Figure 2. 3D Modelling in Rhinoceros, Sengke and Atmodiwirjo (2016).

In applying the 3D isovist formula, Boundary Representations (Brep) was set to the 3D model and Point was set to the Point in 3D model so it will make a link and create the 3D isovist in the 3D model. A point was set on the position where the eyes are located. In this case the position of the eyes were adjusted with the patients position while lying on the bed. By using isovist analysis in one point of view, it is possible to detect the visible area and generate the shape of that area.
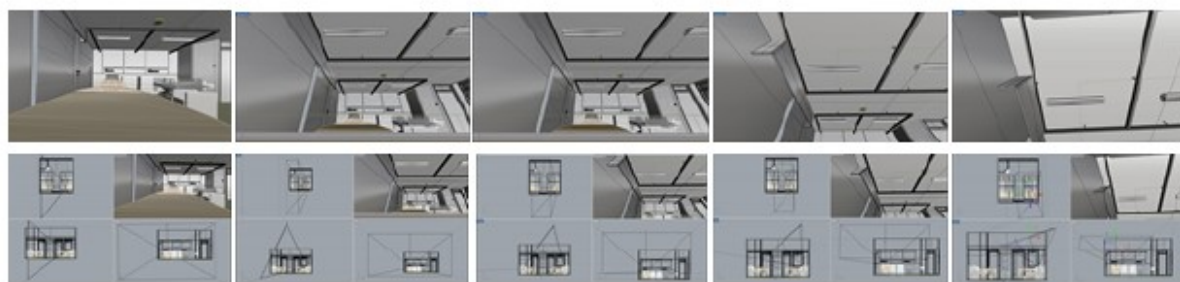
4. Findings

The findings indicates the visibility area of the patients into two parts: the analysis of seeing from certain point of view and the analysis of space that is being seen.

4.1. Analysis of Seeing from Certain Point of View

This analysis revealed the elements interior that are within the patient's field of view when seeing happen in a movement along one axis. Coinciding some interior elements did not found in the range of the patient's visual. That is mean elements interior are in the area of the blind spot. The elements such as: floor surface, the surface area of the wall behind the patient, the head of the bed, the identity on the front bed and hospital equipment that are placed beyond the visual range. This condition may caused the patient is lack of information.
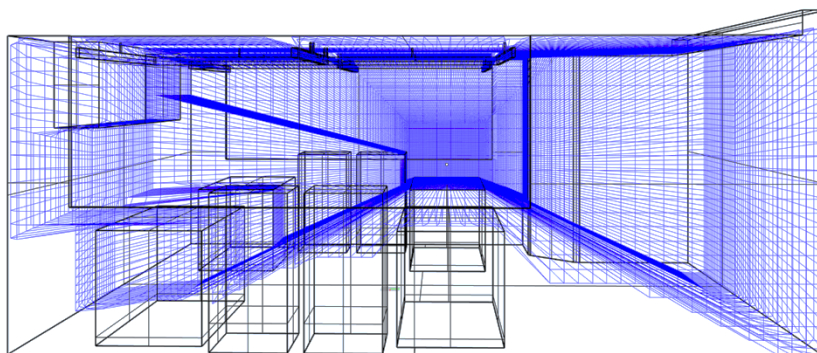

Figure 3. Perspective Scene in the z-axis motion and the motion camera angles for the z-axis produces the movement from left to the right view, Sengke and Atmodiwirjo (2016).
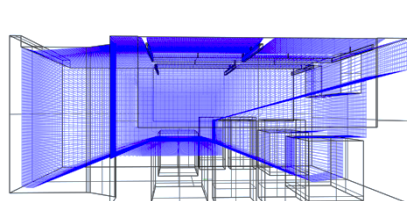

Figure 4. Display images in the visual range based on on the y-axis motion which produces the movement from the front to the top view and the motion camera angle with y-axis, Sengke and Atmodiwirjo (2016).

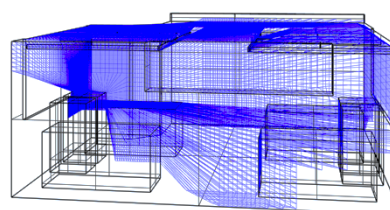### 4.2. Analysis of Space that is Being Seen

The second analysis attempts to simulate the geometric shapes of the patients field of view. The boundary of visibility area shows which area can be seen and which can not be seen by the patient in a lying position on a bed in the inpatient ward. This boundary area show the visual capacity provided by the environment of the patient. Viewpoint from one advantage point in isovist application create the medium of visibility area.

Figure 5a. The point of view that show a wider field of view than the other, Sengke and Atmodiwirjo (2016)

Figure 5b. The Position of the bed that has a field of view close to symmetry, Sengke and Atmodiwirjo (2016)

Figure 5c. The Characteristics of interior elements limit the field of view of patient, Sengke and Atmodiwirjo (2016)

This case shows that some elements were found to be the barriers that limit the field of view of the patients. Some characteristics of the elements such as the height of the cabinet could block the view. The placement of the patients' bed causes some bed to have a wider view than the others. Through isovist analysis, it is revealed how the layout of interior elements in inpatient ward could affect the human visual of field from each patient's position. The interior elements arrangement in inpatient ward, could create a different view for each patient, which may affect their visual experience of space and affect their wellbeing.

5. Conclusion

This on-going research has illustrated that the isovist application could represent the experience of seeing by the patient from particular point of view and also represent the boundary of the visible areas, which can reveal which elements can and cannot seen by the patient. Isovist provides a way to understand the experience of seeing and being seen by visualizing the visibility area through three dimensional modelling.

This study has presented an isovist analytical approach based on the capability of seeing experienced by the patient in bed-ridden condition. The result shows the visibility area of patient which includes the visibility surface and visibility volume from the patient environment. This visibility area plays a role to provide a series of visual information for the patient. The findings of the study shows the interior elements included in the patient's field of view and indicates the surface area that are visible. By understanding the visible surface and interior elements, it is possible to define the positioning of visual information which could stimulate attention from the patient, improve the experiencing of seeing, and give a positive distraction to the patient.

The use of isovist application in studying healthcare environment could enhance the relationship between architecture and health and humans and their environment. Further study will develop this analysis by looking in more details the field of view of patients in hopital ward in relation to the presence of architecture and interior objects or elements.

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