Using Isovist Views to Study Placement of Large Displays in Natural Settings

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Abstract

In this paper we present the concept of an *isovist*, derived from the architectural literature, and describe how isovists can help HCI researchers understand visibility in a physical environment. An isovist is defined as the set of all points visible in all directions from a given vantage point in space. The overlap in isovists from two or more locations can be used to assess reciprocal visibility and thereby assist in the placement of large displays for public or shared use. We illustrate the value of isovists for HCI research using field data from two OR suites in two major urban hospitals. First, we show how patterns of interaction between anesthesiologists and nurses in each of two OR suites are associated with quantity of isovist overlap. Then, we show how an isovist analysis can be used to determine a better placement for the shared display in one of the OR suites to enhance coordination between groups.

Keywords

isovist, space syntax, physical environment, collaborative work, large shared display, privacy.

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ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI).

Introduction

It is well known that the arrangement of a physical space, such as the hallways, offices, and common areas in a building, can influence the frequency of informal interaction among inhabitants of that space (e.g., [1], [4],[6],[9]). Even when people are separated by the same distance, visual barriers such as walls and stairways reduce opportunities to make eye contact with one another [4] and initiate interaction [9].

Despite the extensive literature on the effects of distance and visibility on interaction, it is difficult to generate specific predictions. For example, some workplaces use large displays of information such as customer orders in restaurants and surgery schedules in hospitals. Where should these displays be located in a given building such that informal interaction is maximized? Where should they be located so that the displays can be shared by employees who need them but out of the view of non-employees? How does the mobility of people in the environment affect the visibility of such displays? In HCI research large displays have been studied with regards to: social and interactional aspects (e.g., [11]), the effects of display location on user input (e.g., [20]), and display impact on individual performance (e.g., [17]). In this paper, we introduce the concept of an *isovist* [2], derived from architectural literature, and show how it may be applied to our research questions. After defining isovists and describing their calculation, we illustrate the application of isovists in the context of an ongoing field investigation of coordination between nurses and anesthesiologists in two operating room (OR) suites. We conclude that isovists may be used to identify suitable locations for public displays within an environment.

What is an Isovist?

Benedikt [2] describes an isovist as the set of all points visible in all directions from a given vantage point in space with respect to an environment. The left and center panels in Figure 1 show isovist views from two locations (labeled Point 1 and Point 2) in a small part of a hypothetical building. Thick, dark lines indicate walls. The right panel shows the overlap area of the two separate isovists—the set of points visible from both Point 1 and Point 2. In technical language, the diagram in the right panel is called a *first order visibility relationship*—the overlap of views of two points that are reciprocally visible [19].

Isovists and their areas of overlap can be used to determine how the location of large displays within an environment affects their visibility. In Figure 1, we illustrate this process for four possible locations of a public display (*a*, *b*, *c,* and *d*), given points 1 and 2. The left panel shows the isovist from Point 1. Note that locations *a* and *c* are visible but *b* and *d* are not. The center panel shows the isovist from Point 2. Here, locations *a* and *d* are visible but *b* and *c* are not. From an analysis of the overlap of isovists, we can see that location *a* is visible from both Points 1 and 2 and is therefore the best spot for a public display that people at both points are intended to share. In contrast, location *c* is a good place for a display that is intended to be private for people at Point 1.

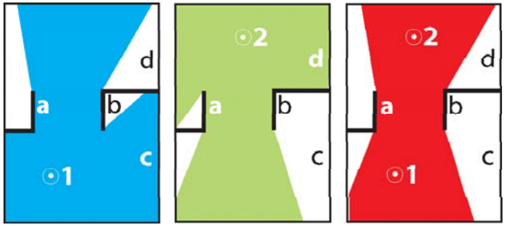

Figure 1. On the left is the isovist taken from Point 1; note that locations *a* and *c* are visible but *b* and *d* are not. In the center is the isovist from Point 2; note that locations *a* and *d* are visible but *b* and *c* are not. On the right is the overlap in isovists; note that only location *a* is visible from both Points 1 and 2.

A second type of isovist analysis is called the *isovist visibility graph* [19]. Isovist visibility graphs show how visible each point in a space is to all other points in that space (see Figure 2). To develop the visibility graph, one isovist is calculated for each square and the visibility of each square is determined by overlapping all of the generated isovists. In Figure 2, red represents the most visible squares, and blue represents the least visible squares. Other colors indicate intermediate levels of visibility. Isovist visibility graphs can be useful for positioning public displays and other shared artifacts in environments in which people will be moving around. For example, locating a public display in area *a* of Figure 2 will guarantee that it will be highly visible to people moving through the environment. Locating the display in positions *b* or *e* will ensure that it is minimally visible from any vantage point.

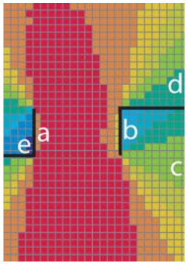

Figure 2. Isovist visibility graph of a floorplan similar to that in Figure 2. Red indicates the most visible locations and blue indicates the least visible locations. Shades inbetween have intermediate visibility.

Case Study: Isovist Views in Two Operating Room Suites

We illustrate the value of calculating isovists using field data we collected from two OR suites in two major urban teaching hospitals. The goal of this project was to understand how the positioning of the OR schedule whiteboard affected interactions between anesthesiologists and nurses. As part of this project, we spent over 200 hours observing activity at two OR schedule whiteboards located in different OR Suites (which we call A and B). Even though both hospitals are part of the same health organization the two OR suites significantly differ in how the whiteboard is positioned (see Figure 3). In OR Suite A, the whiteboard was located in a hallway around the corner from the OR front desk where the nurses were stationed. In OR Suite B, it was positioned adjacent to the OR front desk. Because anesthesiologists frequently pass by and look at the OR schedule whiteboard, the mutual visibility of the whiteboard and front desk were expected to influence informal interaction between anesthesiologists and nurses.

Isovist Analysis of OR Suite Whiteboards

We constructed isovists for each of the OR suites. The top panel in Figure 4 shows a schematic representation of Hospital A with the isovists visible from the OR front desk (left) and the OR schedule whiteboard (center). As can be seen from the overlap of isovists (right), there is minimal overlap in views from the OR front desk and whiteboard, and no reciprocal visibility. That is, members of the anesthesia team and nurses at the OR front desk cannot see one other from their respective locations.

The bottom panel in Figure 4 shows a similar analysis from OR Suite B, in which the whiteboard was located adjacent to the OR front desk. Here, the isovist from the OR front desk (left) and the OR schedule whiteboard (center) overlap considerably, as can be seen in the rightmost panel of figure 4. Thus, members of the anesthesiology and nursing teams in OR Suite B have many more opportunities to encounter one another in their daily activities.

Figure 3. Basic layout of OR Suite A (left) and OR Suite B (right). Position 1 indicates where the nurses at the OR front desk are located; position 2 indicates where the OR schedule whiteboard is located. Dark lines represent walls. Lighter lines around Point 1 represent the OR front desk.

Because mutual eye contact is one way in which informal interactions are initiated [8], we would expect these differences in the location of the whiteboard to affect the frequency of face-to-face interaction between anesthesiologists and nurses. During our extensive observations of both OR Suites, we coded all face-to-face interactions at the whiteboards in terms of which categories of personnel were involved (e.g., anesthesiologists, nurses, surgeons). As shown in Table 1, interaction between nurses and anesthesiologists was far less likely to occur at the whiteboard in OR Suite A (7%), where there was minimal isovist overlap, than at the whiteboard in OR Suite B (44%), where there was high isovist overlap. Given the importance of informal communication for OR coordination (e.g.,[16]), this difference is profound. Although anesthesiologists and nurses in OR Suite A can still communicate (e.g., by phoning or walking over to one another's areas), research on informal

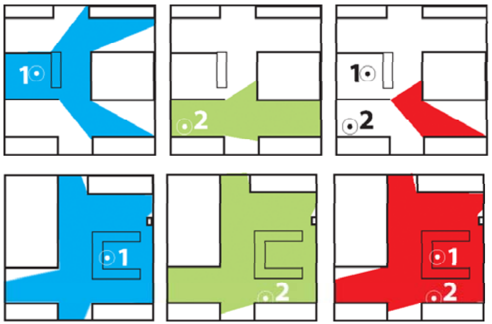

Figure 4. Isovist analysis of OR Suite A (top) and OR Suite B (bottom). In both, the left panel shows the isovist view from the OR front desk; the center panel shows the isovist view from the OR schedule whiteboard, and the right panel shows the overlap between views.

communication suggests that their overall level of interaction will be lower than when they encounter one another in the course of their daily activities [4],[9].

	OR Suite A	OR Suite B
Overlap in isovists between OR front desk and OR schedule whiteboard	Minimal overlap, no reciprocal visibility	High overlap, reciprocal visibility
Percent of conversations involving anesthesiologists and nurses	7%	44%

Table 1. Isovist view overlap between OR front desk and OR schedule whiteboard and percent of face-to-face conversations involving anesthesiologists and OR front desk nurses.

Repositioning a Public Display to Increase Interaction

Next, we used isovist analyses to determine how to reposition the whiteboard in OR Suite A to increase interaction between anesthesiologists and nurses. In Figure 5, the original overlap in isovists between the OR front desk and the whiteboard is shown on the left. We then calculated new isovists for two alternative whiteboard locations: across from the OR front desk (center panel) and further down the hallway (right panel). An isovist analysis suggests that locating the whiteboard across from the OR front desk would be preferable because the total area of reciprocal visibility is larger. However, if there is a need to have the whiteboard somewhat removed (e.g., to ensure privacy of patient information), moving it down the hall would be preferable to leaving it where it is. In future work, we can test these conclusions by moving the whiteboard to these alternative locations and observing interactions between anesthesiologists and nurses.

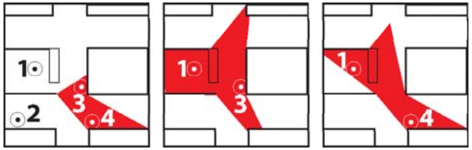

Figure 5. Isovists from alternative positionings of the whiteboard in OR Suite A.

Discussion

The concept of isovists relates to Gibson's notion of affordances. For Gibson, affordances describe the relationship between observer and an object [5]. For an observer a set of affordances in an environment is called a niche of affordances. Although isovists and affordances are related concepts, isovists allow mathematical prediction of how changing the positioning of a display and interaction partners will affect behavior, whereas affordances are descriptive in nature. Affordances guide users to possible actions (e.g., [10]). In this study, we describe two whiteboards that have the same affordances for anesthesiologists and OR nurses; only the locations of anesthesiologists and OR nurses in relation to the whiteboards differ. We suggest isovist analysis is useful to determine the location of a shared display and predict interaction between groups.

The optimal location of a shared display may seem like a trivial problem for groups collocated in one environment. However, the location of a shared display in a complex hospital environment where groups move from one room to the other is very critical. For example, anesthesiologists may attend to multiple surgery patients at any given time in different rooms. Anesthesiologists follow their patients from the pre-operation room, to the OR, to the Post-Anesthesia Care Unit and so forth. Maximizing isovist overlap of the whiteboard and front desk increases coordination opportunities in such a dynamic environment.

Conclusions and Future Directions

In this paper we have shown how isovists can help researchers understand how the physical characteristics of a work environment and the positioning of public displays and other shared artifacts within that environment affect reciprocal visibility among collocated individuals. Isovist analyses can be used to assess the ideal location of a public display within a physical environment, such that either opportunities for interaction or needs for privacy are maximized. Even though we studied an analog whiteboard, the isovist analysis presented in this paper is relevant to HCI because the same methods described can be used to position digital displays and predict social interaction.

The use of isovists does, however, have limitations. For example, isovists do not take people's customary line of sight from a given point into account; rather, they assume equal visual access in 360 degrees. A more refined analysis would need to consider how much time people spend looking in each direction. In addition, when considering the impact of isovists on behavior, investigators have not considered such factors as the relationship between individuals at different locations. Mutual visibility is likely to have different consequences depending upon whether people have interdependent tasks. In our future work in hospital OR settings, we plan to refine the calculation of isovists to take these factors into account.

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