NAVIGATION IN INFORMATION SPACE

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ABSTRACT

Information seekers often need to perceive the organization of the document content to find the destination in the information space. Much of this task involves navigating the information space. This article primarily delineates essential premises concerning navigation in information space. The paper also discusses how cognitive abilities, particularly spatial ability, affects user's navigation pattern. Problematic issues such as *Lost in Hyperspace* and *Cognitive Overhead* are also discussed. Finally, this paper explores prospective ideas and schemes to make navigation more effective and enjoyable in future.

KEYWORDS

Navigation, cognitive ability, information space, lost-in-hyperspace.

1. INTRODUCTION

Navigation is the process of moving from one location to another in a spatial environment and knowing the relative position in order to reach an intended destination. Navigation includes understanding, partitioning an environment, exploring it and finding the right way to the end from starting point (Benyon, 2001). In his framework for navigation, Spence (1999) explained navigation as the act of browsing using a browsing strategy, which is developed from the interpretation of the internal model that people create from the content of the space.

Information space is the structured collection of information consisting of various information artifacts and signs from where subjects seek information for their activity space. In order to explain the notion Information Space, Benyon (2001) introduced the idea of *activity space*. Activity space is the physical spatial environment where people perform a certain activity. According to study, visualizing an information space is necessary for effective navigation (Dieberger, 1997). People often impose metaphors to information space to give it a visual structure. Apart from the large body of information contained in it, an information space can be seen as a set of nodes, each of which is an information unit or sign (van Dyke Parunak, 1989). The topology of these nodes makes it resemble like a space for routing. The complete structure takes a shape like a city or town where the way-finder is not forced to take any single path to reach a destination. In this sense, hypermedia is the most vivid example of an information space. Besides, newspapers, television and even a single autonomous computer or paper document can be treated as an information space. The evolution of the WWW over past several years is astounding. Due to its huge information content and complexity in navigation, salience and structure has the potential to make it a highly complex information space for information users.

Navigation in information space can be considered as the process where user moves through the virtual information network by following links from node to node and senses her position in the network relative to the destination node. This definition does not require a strict distance measure. Based on the size, orientation and structure, the navigation mechanism varies from one information space to other. In the next section, we describe basic navigation mechanisms for contemporary information networks. After that, we discuss how cognitive abilities influence individual's act of navigation. We also present the major aspects that impede the usability of a navigation method. In the closing section, we anticipate the trends in the next generation navigation by exploring current research in the HCI community.

2. REVISITING BASIC NAVIGATION MECHANISMS

According to Robertson (1997), navigation methods can be classified into three broad categories — e*go-centric navigation*, *transformation and/or manipulation of objects* and *agent driven navigation*. Ego-centric navigation is the most common type of navigation activity where user navigates the space like clicking links on a hypermedia, zooming in or zooming out a 3D model, etc. User shows a point of interest in the navigation space and moves to that point through this type of activities. Visualizing the information space as a non-abstract model has been denoted as Transformation and/or manipulation of objects (Robertson, 1997). Users tend to orient the information space that fits best with her perceptive style. The third basic navigation act is called agent driven navigation. In this type of activity, an agent guides the user in navigating the information space. Search engines in the WWW, clustering model for any kind of corpus, etc. are some agent models that drive this kind of navigation.

Van Dyke (1989) identifies five basic navigational strategies by examining at information space from a graph topological view. First in the list is *Identifier*. The Identifier strategy attaches a description, or recognizing notion, to each node. The *Path* strategy tells user the route to the destination in a hop-by-hop manner. The next strategy, *Direction*, differs from Path in the sense that Path information is local to each information node and directs user to next path originating from current node whereas Direction is a global sense. User tries to predict a much broader direction for the path from current position in the information space. A slight variation of Path strategy is found in *Distance* strategy. Distance measure is like radius of a circle around user's current location for searching the destination. The fifth and final strategy is *Address*, which divides the search space in a grid-like fashion and attaches a global identifier to each node.

Now, well-accredited navigation schemes are presented in aiding information seeking in complex spaces. *Guided navigation* is the most primeval way of assisting users in their wayfinding. *Trailing* is one of the oldest but useful concepts in this class. Trailing in navigation refers to the list of nodes of the information space that user visit on her way to find the destination. This information helps in backtracking if the user navigates through a wrong path towards the goal. *Tour* is another closely related guided navigation. The difference between tour and trail is that user creates the trail through navigation whereas tour is previously built linear order of nodes to guide user (Greer & Philip, 1997). The facility of storing history and backtracking in them are very important features of any navigation model. *Bookmarking* or *landmarking* is another significant feature in traditional navigation models. Bookmarks or landmarks are selected nodes in the list that helps in determining the position of the user in the information space (Navigation in Hypermedia, 2002). Among other stereotype navigation methods, there are *Geometric Navigation* and *Chronometric Navigation* (Schulmeister, n.d.). Geometric Navigation uses the concepts of compass, map, floor plan and other spatial elements in navigation. Chronometric Navigation uses time line, data line and other chronological principles for surfing information space. *Semantic Navigation* (Schulmeister n.d.), being a relatively new concept in navigation, should not be classified as a traditional navigation approach. It connects the nodes in the information space based on their semantic relation and hence the navigation, indeed, takes place in semantic information space.

3. COGNITIVE ABILITIES AND NAVIGATION

Cognitive abilities or structures are property of the mind, which are generated from brain and nervous system and influence human behavior in social and physical world. Human cognition refers to the knowledge that is used in manipulation, storage, retrieval and acquisition. Individuals differ in their cognitive abilities when they exercise intelligence and use perception, reasoning, problem solving and memory.

Höök & Dahlbäck (1997) found that people with higher spatial cognition do much better in navigation. Cognitive abilities are correlated with information spaces especially verbal and graphical interfaces (Dahlbäck & Lonqvist, 2000). Much research has been conducted to find the relation between cognitive attributes and navigation in the information space. In (Höök & Dahlbäck, 1997), the study includes verbal, logical-inductive, perceptual analysis and spatial ability to investigate whether they are related to the navigation. Both Benyon & Murray (1993) and Dahlbäck, et al. (1996) found correlations between performance on navigation in information space and the user's spatial cognitive ability. Again, weakening the metaphor issue, another study shows that there are different set of cognitive abilities in navigation in physical world and navigation in information space like hypermedia. They are not identically same but possess similarity in the sense that both utilize orthogonal spatial ability (Höök & Dahlbäck, 1997). In another study by Dahlbäck & Gustavsson (2000), the impact of spatial ability is found slim in non-spatial information spaces. However, we will go into detail on spatial ability and mental model that apparently dominate user's navigation pattern in the interaction space.

3.1 Spatial Ability and Mental Model in Navigation

It is clear from our above discussion that spatial cognitive ability is the principle factor that plays the game while users navigate in an information space. Spatial ability is the cognition of spatial properties of the world like location, size, distance, direction, shape, movement, etc. In the context of navigation, it is the perceptual ability on the information space based on the user's previously acquired knowledge, information processing capability and motor capability on spatial properties in real world.

For the comprehension of an information space, users develop a mental model of the search space, which is primarily influenced by their spatial ability. Previous research suggests that users, while navigating, form three types of mental model over time, based on their spatial cognitive abilities (Dillon, 1997). These are *landmark*, *route and survey* mental models. Landmark knowledge is built in the beginning of interaction. A person tries to acquire knowledge on unique, stable spatial configurations of the space to get an idea of the topology. Dillon (1997) defines route knowledge as the "ability to navigate from point A to point B, using whatever landmark knowledge we have acquired to make decisions about when to turn left or right". So, route knowledge can be seen as the path or sequence of landmarks. The last but not least is survey knowledge. It is developed in the later part of the navigation session. Survey knowledge helps in locating landmarks and routes within a general frame of reference.

To help in creating better mental model, that can comprehend the information space, another important factor has been identified — *Coherence* (Thuring et al., 1995). Empirical studies show that any hypertext document's readability depends on its degree of coherence. Local Coherence is the relation between clauses and sentences and Global Coherence helps in drawing goal or conclusion of the document from a chunk of text (Thuring et al., 1995). The idea of coherence can be extended for the generic information space concept we mentioned earlier. Besides, another factor that influences spatial cognition hence the overall mental model is *constancy* of objects in the information space (Raubal, n.d.). Constancy of objects includes color scheme, size and visual orientation of the object.

3.2 Other Influencing Factors in Navigation

Some other parameters that stir up individual's navigation pattern include gender, physical disability and learning technique. Males and females navigate through the real world using different strategies (Halpern, 2000; Kimura, 1999). Males are more efficient in navigating virtual information space, but females can take wider view of the search space than males (Czerwinski et al., 2002). Visually impaired people can hardly navigate in any information space. Much research has been done and are under way for vision impaired people. In (Kennel et al., 1996), authors suggest Web Access for Blind (WAB), a different hypertext structure, for vision disables. Learning technique is another important factor that influence navigation pattern. Dillon (1991) brought the idea that readers of scholarly works presuppose an IMRD (Introduction, Method, Results and Discussion). Most of the prevalent documents have structure to condition users learn this format and hence they expect to find a similar structure when they navigate an unfamiliar document.

4. NAVIGATION PROBLEMS IN INFORMATION SPACE

Not long ago, problems in navigation were treated as myth and artifact of early contribution to navigation research. But, as the dimension and volume of some information space like hypertext and the WWW has grown remarkably in last few years, the issue has drawn significant respect again from the HCI community. A large information space such as the World Wide Web (WWW) can simultaneously disorient, confuse and distract the information seekers during navigation. A common phenomenon as experienced by the users in hyperspace is *Lost in Hyperspace* (Edwards & Hardman, 1999). We will, now, focus on some of the crucial navigation problems usually encounter in information space.

4.1 Lost in Hyperspace

Lost in Hyperspace is the state of feeling lost by the user due to huge magnitude of information in the interaction space especially in hyperspace (Smith, 1986). It is the problem of disorientation from too many jumps while navigating a large information space. Information specialists possess mixed opinion about this problem. Some people take it as a pedagogical myth from hypertext specialists. Bernstein as found in (Schulmeister, n.d.) thinks that lost in hyperspace problem originates partly because of user interface designer and partly from the early design of hypertext. Some doubts about the significance of the problem in information world where other thinks that the best effort is yet to come to resolve it (Theng, 1999). But, Theng (1999) carried out experiment that confirms its prevalence in digital library navigation. A good number of researchers are working in solving the problem by designing more robust, effective and usable navigation tools.

4.2 Cognitive Overhead

Conklin defines *Cognitive Overhead*, as stated in (Thuring et al., 1995), as “the additional effort and concentration necessary to maintain several tasks or trails at one time”. Although the definition is in the context of hyperspace, the concept is almost same for all other interaction spaces. A well-designed navigation platform always minimizes cognitive overhead. Cognitive Overhead depends on the information processing capability of humans. So, it may vary among individuals for a fixed navigation system and search space. Navigation is not the only source for creating cognitive overhead in users mental model. Orientation and user interface are also responsible for this problem (Thuring et al., 1995).

4.3 Serendipity

Serendipity is the reverse concept of lost in hyperspace! Sometimes, user reaches a place, which is more attractive than the original destination. User does not think herself lost, rather feels lucky although she is more or less lost indeed. In this sense, serendipity may not sound like a navigation problem to the readers in the first place. But, it is, in fact, a phenomenon that shifts the primary information-seeking goal and should be categorized as a weak point of the system. Again, there is dispute in this issue. Some people see it as a “delightful discovery by accident” and others disagree with them (Cooper-Kuhlen, 1992).

4.4 Segmentation and Contextualization

Segmentation and Contextualization are sometimes responsible for ineffective navigation in the search space (Cooper-Kuhlen, 1992). The atomization of information and creating nodes in the information space sometimes make too many chunks. Too many segments make the system too complicated to navigate. The opposite hypothesis is contextualization. Each information entity or node or unit is contextualized to groups, which may bring the risk of unsatisfactory navigation experience.

5. CURRENT RESEARCH AND EMERGENT TRENDS IN NAVIGATION

In this section, we will bring up some prospective works in navigation research for information space. An exhaustive citation is out of scope of this document. The emergence of Adaptive Hypermedia (AH) in late 90s was obviously due to the growth of the WWW, the most complex information space. The proposal of visual annotation in (Brusilovsky & Pesin, 1995) uses AH approach and is designed for user-adapted interaction systems. Another work by Gaura & Newman (2003) looks into the prospect of using AI techniques particularly Artificial Neural Network in designing optimal node structure in hypermedia. A better structure will eventually make the navigation more enjoyable. Another very interesting idea in future generation navigation is *CyberMap* (Gloor, 1991). While navigating using CyberMap, an overview map pops up every time the user moves to a new segment of the information space or page in case of hyperspace. Common path is a continuous learning system that suggests new user the path direction and better suitable in a group environment (Barra et al., 2003). Czerwinski & Larson (1998) suggest extensive use of User Modeling (UM) for new navigation technology. The paper is an excellent source of some novel trends in this research area. In multidimensional information space, orientation and gesture are more complex than two-dimensional space. Experiment, carried out by Allport et al. (1995), postulates the effectiveness of hand gestures to walk through large multidimensional information spaces. Zoom Navigation is a new drift in future generation navigation. Any information space can be represented in graph structure and zoom algorithms usually works on such structures. Ruger et al. (1996) propose such a scheme, which is pluggable in nature. The back end schema facilitates to plug it into different information spaces using topology of the nodes. Finally, we will talk about an ambitious direction in navigation research. Kaplan (1997) sees the potentiality of ontology driven navigation tool that can represent the hidden semantic information among nodes in the search space. This abstract space, in his words, is entitled as one “where no mind has gone before”.

6. CONCLUSION

In this paper, we tried to explain the popular concepts and issues about navigation of information. Although we only briefly touched the amount of knowledge considered critical for navigation research, the guidelines in the previous section can be pursued to do further works and empirical studies in this area. We underline the necessity of addressing the problems and hinted what it will take to build widely acceptable, enjoyable navigation tool for tomorrow. We would like to continue examining this field and wish to come up with prototypes for more usable navigation in information environments.

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