An Exploratory Study on Visual Attention and Behavior of Users in Hotel Search Process

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Abstract

A number of reports have identified the Internet as the preferred channel for making travel enquiries and holiday booking. With regard to today’s online environment and advanced technology, a close investigation for visual attention and behavior of users is crucial since only a few mouse clicks can retrieve a huge amount of information. It is difficult to figure out decision making processes of online consumers due to many interference factors such as images, color, amount of text and etc. Moreover, few have addressed the process of online decision making as hotel purchasing is more complex and cognitively demanding than other products.

This paper demonstrated that the complexities of the user decision process in hotel searching on the Internet. In this study, it is discussed that how we evaluate users’ visual attention and behavior in hotel search process. Also, it examined the use of eye tracking in Human Computer Interaction(HCI) and usability study. It allows for a more advanced assessment of the information seeking process by providing a practical guide to researchers of the various eye movement measures. Finally, various opportunities and challenges for eye movement studies were suggested for further research.

Keywords: human computer interaction(HCI), eye tracking, visual attention and behavior, hotel search process

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I. Introduction

There is no question that the 21st century has been qualified as an “e” generation era. Finding online information using search engines has become a part of everyday lives (Gordon and Pathak, 1999). Moreover, the rapid acceptance of the Internet phenomenon has generated to all aspects in everyone’s daily life starting from e-Mail, e-Commerce, e-Business, e-Test, e-Learning, e-Government to e-Hospital. It is obvious that the Internet has been widely used in many sales and marketing activities, giving the opportunity to almost anyone to purchase goods and services without visiting shops. According to Li and Gery (2000), using the Internet as a shopping medium people can shop twenty-four hours a day, seven days a week without worrying about store hours, weekends, time zones or traffic jams.

It is certain that the Internet has taken center stage as the hotel reservation method of choice worldwide. With the advent of the Internet technology, online channels contributed 56.9 percent of the top 30 hotel brands in 2010 (Hotels, 2011). Hence, it is important to evaluate this online user population and take full advantage of the Internet and its facilities.

Over the past decade, Human Computer Interaction (HCI) has received an increasing amount of attention from a broad range audiences, since the role and importance of the Internet has been recognized and acknowledged. Simply stated, HCI is the study of interaction between people and computers. It is important that till today, the main research instrument of HCI was the questionnaire or the interview and this lead to many ‘grey’ areas. As a result, uninvestigated process was regarded as unavoidable consequence since the user’s intention was normally hard to measure. Even though there are large numbers of studies on HCI, the behavioral aspects are still ignored. Since few studies have explored the area of online decision making, and none about online decision making about hotels, very little is known about the cognitive factors, such as critical customers’ information requirements and behavioral factors. Cognitive factors can be utilized in investigating actual influence and impact on users’ decision making process when they come to book their hotels online.

To date, the process of evaluating users’ Internet search behavior of hotel/travel reservation has
received little attention. Eye tracking is a promising tool for this purpose as it provides information on visual information processing. Eye tracking devices are able to record eye movements and reveal subjects’ attention and cognitive process.

Therefore, the purpose of this study is to overview users’ internet search behavior, and to progress toward a detailed discussion of the use of eye tracking in HCI and usability study. It allows for a more complete assessment of the information seeking process by providing a practical guide to researchers of the various eye movement measures. Moreover, it is illustrated advantages and shortcomings of eye tracking application. It is concluded by considering the future prospects for eye tracking research in hotel decision making process.

II. Research on Users’ Internet Search Behavior

1. Human Computer Interaction(HCI) Research

Human Computer Interaction(HCI) is a term mainly used to provide information regarding the understanding and designing of different relationships between people and computers. Human computer interaction is an area of applied cognitive science and engineering design. It is concerned both with understanding how people make use of devices and systems that incorporate computation, and with designing new devices and systems that enhance human performance and experience. Interaction is a concept to be distinguished from another similar term, interface. Roughly speaking, interaction refers to an abstract model by which humans interact with the computing device for a given task, and an interface is a choice of technical realization of such a given interaction model. Thus, the letter I in HCI refers to both interaction and interface, encompassing the abstract model and the technological methodology(Turban & Aronson, 2003).

Aside from merely making the necessary computational functionalities available, the early focus of HCI has been in how to design interaction and implement interfaces for high usability. At the outset, in the late 1970s, the main concern of HCI was ‘usability’. Since then, HCI has established
an impressive track record for developing and applying all manner of design and evaluation methods to ensure that technologies are easy to learn and use. HCI has become much more important in recent years as computers have become commonplace in almost all facets of our lives. The term high usability means that the resulting interfaces are easy to use, efficient for the task, ensure safety, and lead to a correct completion of the task. Usable and efficient interaction with the computing device in turn translates to higher productivity.

2. Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) constitutes an important extension of Ajzen and Fishbein’s Theory of Reasoned Action (TRA) and it was introduced in 1986 (Davis et al., 1989). TAM theory addresses the issue of how customers come to accept and use a particular technology. According to the model, when users are presented with a new technology, a number of variables influence their decisions about how and when they will use it. The model introduces two specific variables - perceived usefulness and perceived ease of use, which are hypothesized to be fundamental determinants of user acceptance (Davis, 1989).

According to Monsuwe et al. (2004), there are two principle determinants of a person’s attitude toward using technology and online facilities. Perceived usefulness is defined as the degree to which a person believes that using a particular technology will enhance his or her job performance (Davis et al., 1989). People tend to use or not to use an application to the extent they believe it will help them perform their job better. Davis et al. (1989) proposed that perceived usefulness explains the user's perception to the extent that the technology will improve the user's workplace performance. On the other hand, perceived ease of use refers to the degree to which a person believes that using a particular technology will be free of effort. Perceived ease of use explains the user's perception of the amount of effort required to utilize the system or the extent to which a user believes that using a particular technology will be effortless. In general, the technology acceptance model (TAM) is tailored-made for modeling user acceptance of information technology.
3. Internet-based Decision Models

The Internet has gained considerable importance as a communicative and adaptive means of sharing and disseminating information (Shin et al., 2015; Kim & Jung, 2014). From a consumer behavior perspective, the Internet offers diverse kinds of convenience to search information, evaluate, purchase, and use products more efficiently and effectively than other channels to satisfy their needs. The Internet can enhance consumer efficiency by facilitating consumers’ access to consumption related information more quickly and save time, effort, and cost. As a result, the Internet is likely to replace traditional distribution and communication channels and evolve as a channel with much potential.

To date, relatively few studies have investigated the impact of the Internet on users decision in hotel search process. Alba et al. (1997) demonstrated the factors that motivate both consumers and marketers to become involved in electronic home shopping. McGaughey and Mason (1998) discussed the influence of the Internet on consumer behavior through each step of consumer decision making. Han et al. (1998) proposed the factors that influence consumer buying intentions through the Internet, such as challenging mindsets towards the Internet, Internet usage skill, perceived risk, perceived service quality, and involvement. Darley et al. (2010) used the main five stages of this model and added the impact of beliefs, attitudes and intentions in the process. They provide additional influential factors, but their model is too strict and cannot apply in online decision making process.

Solomon (2002) argued that generalization of the process is not applicable where consumers change their strategy based on the product, service, situation, context and previous experiences. Additionally, all these models are not concerned with the actual information needs of users. At the end of the day, these information pieces might influence the entire process and post-purchase behavior. Online purchase is more complicated than searching for a product to satisfy users’ needs. Online decision making process cannot be standardized, as a user can go back from one stage to another many times before the final formulation of decision. Smith and Rupp (2003) suggested that an Internet-based model considers external influences of
website marketing efforts and the socio-cultural environment, as well as psychological issues on the online consumer tasks which lead to purchase and postpurchase behavior. According to this model, online decision processes are made up of different interconnected decisions and it is over-simplistic. Lee(2002) developed a model which is based on the classification of factors that influence online purchase, rather than on the stages of decision making. This model argued that there are three phases of online purchase: building trust and confidence(reliability of the website and company), online purchase experience(purchasing process), and after-purchase(delivery, guarantee, return policy) needs. However, no investigation is made on customers critical information requirements that influence the entire decision making process of the users. This model is too general and does not provide a decision making flow.

Karimi(2013) suggested that a decision making process model should be adaptable and more flexible to different situations. As discussed the above, previous studies only partially explained the factors that influence consumer purchasing behavior through the Internet or focused on the marketer’s point of view. That is, they tried to investigate in which cases the Internet is a more efficient marketing channel than traditional offline channels. Moreover, many recent online decision making processes were made, but none of them concentrate its importance on the customer critical information requirements during each decision making stage. Previous models adapt the contextual factors for the Internet context while using the sequential models of traditional purchase.

### III. Eye Tracking Approach

Eye tracking is not a new method for usability testing since it is being used from 1950. However, nowadays it has become a key method for usability testing, especially of webpages. It is used in many areas of research as it provides indisputable, valid, objective and accurate data presenting usability problems and the user’s behavior.

Eye tracking has been used in many studies to investigate people’s attention allocation and cognitive effort. According to Rayner(1998), eye tracking is a relatively expensive research method
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and provides direct capture of eye movement in stimulus-based settings. Eye movement can indicate where a person’s visual attention is directed. For quantitative eye tracking analysis, Goldberg and Kotval (1999) summarized methods for analyzing eye tracking data for computer based usability studies, such as assessing the length of a scan path and comparing fixation durations. Mainstream psychological research has benefited from studying eye movements as they can provide an insight into problem solving, reasoning, mental imagery, and search strategies (Yoon & Narayanan, 2004; Zelinsky & Sheinberg, 1995). Because eye movements provide a window onto so many aspects of cognition, there are also rich opportunities for the application of eye movement analysis as a usability research tool in HCI and related disciplines such as human factors and cognitive ergonomics. Although eye movement analysis is still very much in its infancy in HCI and usability research, issues that are being increasingly studied include the nature and efficacy of information search strategies on menu-based interfaces, and the features of websites that correlate with effective usability (Cowen et al., 2002; Poole et al., 2004).

1. Eye Movement Metrics

One advantage of using an eye tracker is that you can extract objective data from the recordings by using metrics such as time to first fixation, observation count, and etc. The eye tracker allows us to generate heat maps that can be used to demonstrate problem areas, specific areas of interest or gaze plots that illustrate typical behaviors displayed by the users.

During an eye tracking experiment, several measurements are typically recorded. The main measurements used in eye tracking research are fixations and saccades. There are also a multitude of derived metrics that stem from these basic measures, including gaze and scan path measurements. Nowadays pupil size and blink rate are used as well.

Fixation refers to relatively stable eye-in-head position with some threshold of dispersion over some minimum duration. It can be interpreted quite differently depending on the context (Jacob & Karn, 2003). Higher fixation frequency on a particular area can be indicative of greater interest on the target. On the other hand, higher fixation frequency means that the target is complex so it is
difficult to encode for users.

Faster times to first fixation on object or area mean that it has better attention getting properties (Byrne et al., 1999). Strandvall (2008) proposed that time to first fixation compared to other areas of interest, it can show which elements of the page are drawing a user’s attention in the context of the task they are asked to perform.

Fixation length is linked to the processing time applied to the object being fixated (Strandvall, 2008). It is widely accepted that external representations associated with long fixations are not as meaningful to the user as those associated with short fixations.

The number of fixations overall is thought to be negatively correlated with search efficiency (Goldberg & Kotval, 1999). A larger number of fixations indicates less efficient search possibly resulting from a poor arrangement of display elements. The experimenter should consider the relationship of the number of fixations to task time (i.e., longer tasks will usually require more fixations).

<table>
<thead>
<tr>
<th><strong>Saccade Metrics</strong></th>
<th><strong>What It Measures</strong></th>
<th><strong>Authors (Year)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of saccades</td>
<td>More saccades indicate more searching.</td>
<td>Goldberg &amp; Kotval (1999)</td>
</tr>
<tr>
<td>Saccade amplitude</td>
<td>Larger saccades indicate more meaningful cues, as attention is drawn from a distance.</td>
<td>Goldberg et al. (2002)</td>
</tr>
<tr>
<td>Regressive saccades (regressions)</td>
<td>Regressions indicate the presence of less meaningful cues.</td>
<td>Sibert et al. (2000)</td>
</tr>
<tr>
<td>Saccades revealing marked directional shifts</td>
<td>Any saccade larger than 90 degrees from the saccade that preceded it shows a rapid change in direction. This could mean that the user’s goals have changed or the interface layout does not match the user’s expectations.</td>
<td>Cowen et al. (2002)</td>
</tr>
</tbody>
</table>

Source: adapted from Poole and Ball (2005)

Fixation rate is closely related to fixation duration. Since the time between fixations (typically short duration saccadic eye movements) is relatively small compared with the time spent fixating, fixation rate should be approximately the inverse of the mean
fixation duration.

Saccades are the lines from one fixation to another. It is important that no encoding takes place during saccades, so they cannot tell anything about the complexity or salience of an object in the interface. Rayner and Pollatsek(1989) argued that regressive saccades can act as a measure of processing difficulty during encoding. Table 1. summarized that saccades metrics and how they can be interpreted in the context of interface design and usability evaluation in previous research.

Gaze duration is cumulative duration and average spatial location of a series of consecutive fixations within an area of interest(AOI)(Hauland, 2003). Gaze duration typically includes several fixations and may include the relatively small amount of time for the short saccades between these fixations. A fixation occurring outside the area of interest marks the end of the gaze. The proportion of gaze time at a particular display element could reflect the importance of that element.

Although the metrics presented above are the most popular, they are not necessarily always the best metrics to apply. There are other promising eye tracking metrics to consider. Scan path(sequence of fixations) and derived measures such as the transition probability between areas of interest can indicate the efficiency of the arrangement of elements in the user interface.

Observation length is the total time in seconds for every time a person has looked within an AOI, starting with a fixation inside the AOI and ending with a fixation outside the AOI. Using this statistic, researcher may notice a block of text receives less than a second of total observations, indicating users have not read the messaging in full. Or researcher may notice in combination with the percentage fixated metric that while an element of a page may not have been seen by a lot of participants, when it was seen, it received a lot of attention (Strandvall, 2008).

Mouse click count is the number of mouse clicks within the same AOI. Observation count is the number of visits and re-visits to an AOI. Strandvall(2008) demonstrated that each individual visit is defined as the interval of time between the first fixation on the AOI and the next fixation outside the AOI.

In addition, there are other aspects of ocular-motor performance such as blink rate, pupil changes and etc.(Hoeks & Levelt, 1993; Backs & Walrath, 1992) Blink rate and pupil size can be used as an index of cognitive workload. A lower blink is assumed to indicate a higher workload and larger
pupils may also indicate more cognitive effort. However, these have been considered annoying problems by most eye movement researchers in the past. On the other hand, they might be a rich source of data in eye tracking study. For instance, Brookings et al.(1996) suggested that blink rate is more sensitive to workload related to task difficulty than many other more conventionally used eye tracking measures including saccade rate and amplitude in a demanding visual task.

2. Think Aloud Technique

According to Hyrskykari et al.(2008), for usability research, eye tracking data should be combined with additional qualitative data since eye movements cannot always be clearly interpreted without the participant providing context to the data. As stated above, longer fixations can mean a user found a particular area interesting(Cowen et al., 2002), but on the other hand it can also mean that they found the area difficult to interpret(Hyrskykari et al., 2008). Hence, it is important to attempt to supplement eye tracking data with additional information. It can be gained from the participants about their previous experiences. It is an effective method that he participants are encouraged to speak or think out loud while performing the tasks and the entire process is recorded.

Strandvall(2008) suggested that ‘video cued think aloud method’ stimulated participants to produce manipulative and visual comments. Also, it stimulated participants to comment on usability problems regarding layout and navigation. As a result, this produced less data (comments and words) than eye movement cued think aloud method.

3. Eye Movement Behavior on Web

According to Granka et al.(2004), only a small number of studies have been conducted on eye movement behavior on web pages. Visual preferences of text and images have been explored by Ellis et al.(1998). In this study, they conducted a pilot study of webpage design to assess the value of eye tracking as a usability evaluation technique. The results of this study indicated that users
completed the task more quickly on text-based screens. This illustrated that overall text was more powerful than images.

Other studies (Outing and Ruel, 2004; Pan et al. 2004) aim to understand the factors that influence user’s visual search behavior. According to Pan et al. (2004), some of these factors, such as individual differences, design characteristics of the webpages, the order in which web pages are viewed and different tasks that were given to the users to complete. Outing and Ruel (2004) discussed how users read news websites. The results of their study indicate that users navigate more on the upper part of news websites rather than on the left or right of the page. Text size was found to be influential in terms of encouraging focused viewing behavior. Smaller text drew more fixations while larger sizes promoted lighter scanning. The users fixated more on headlines with large text rather than headlines with small text. Above studies underline the need for the usage of eye tracking in usability studies.

4. Advantages and Shortcomings of Eye Tracking Technology

There are both advantages and disadvantages of eye tracking methods for usability evaluation. The ability to record one’s micro-flow of visual attention in a non-intrusive way is certainly an advantage, but this can create a huge, tedious data reduction problem. Individual eye movements are quite randomly distributed, often requiring inferential statistics for discovering scanning trends. Strong individual differences are evident, ranging from individuals who scan broadly to those who barely make observable eye movements. Hardware must be frequently calibrated, and subtle differences in eye color or eye kinematics can cause an eye tracking failure. The researchers should certainly weigh these issues before deciding to implement an eye tracking methodology within a usability study.

According to Duchowski (2003), one of the main limitations of eye-tracking is the sampling rate, which can reduce the accuracy by ignoring the micro saccades. Though, the micro saccades are unlikely to be of use in usability (Harrison, 2008). A sampling rate of 60hz is good enough for usability studies, but inadequate for reading research, which requires sampling rates of around...
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500hz or more (Rayner & Pollatsek, 1989). Related researchers need to work with limits of accuracy and resolution. It is also imperative to define areas of interest that are large enough to capture all relevant eye movements. Even the best eye trackers available are only accurate to within one degree of actual point-of-regard (Byrne et al., 1999). Attention can also be directed up to one degree away from measured point-of-regard without moving the eyes (Jacob & Karn, 2003).

Another problem when using eye-tracking for dynamic stimuli such as websites is the problem caused by scrolling of screens and the recording of xy coordinates. However, current software compensates for scrolling activity to ensure the gaze plot is on the appropriate area of the website. Eye data can also be missed because of blinks, resulting in invalid entries (Renshaw et al., 2006). As with any type of software, system errors can also result in incomplete data sets (Harrison, 2008).

Moreover, there are a number of difficulties in data interpretation. Eye tracking generates huge amounts of data, so it is essential to perform filtering and analysis automatically, not only to save time, but also to minimize chances of introducing errors through manual data processing.

There are still questions about eye-tracking that remain largely unanswered such as how can be determined whether someone is attending to or processing the information in their foveal focus (Renshaw et al., 2006). In order to overcome this limitation, think aloud method and video recordings would be useful. Participants were asked to say whatever they are thinking, looking, doing and feeling as they go about their decision-making process for the hotel search. Future developments in eye tracking need to standardized what eye movement metrics are used, how they are referred to, and how they are interpreted in the context of design.

IV. Conclusion

The eye tracking technique has been typically adopted to examine human visual attention based on the eye-mind assumption. In general, eye fixation location reflects attention and eye fixation duration reflects processing difficulty and amount of attention. In other words, the longer the
information is fixated, the more complex it is or the deeper it is processed.

The importance of eye tracking research the usage of special equipment to detect exactly where the users’ eyes are focused when they look at a computer screen. This kind of usability evaluation provides a deeper and clearer understanding of which part of the screen user is more attracted, which is ignored and which is overlooked.

Eye tracking results would be beneficial in three ways. Firstly, they provide the basis for improved interfaces. Secondly, they may suggest more targeted metrics for evaluating the retrieval performance in hotel search. And thirdly, they help interpreting implicit feedback like click through and reading times for machine learning of improved retrieval functions. In particular, better understanding of users’ visual attention and behavior will allow us to draw more accurate inferences about how implicit feedback relates to relative relevance judgments.

Goldberg (2000) discussed which traditional usability criteria can be addressed via eye tracking methods. Understanding this can more effectively determine which aspects of usability assessment can be aided by eye tracking. Eye tracking should generally be an excellent indicator of visual clarity of an interface. Criteria that could be ascertained somewhat from eye tracking include cognitive resources and flexibility of use. Criteria that might be related to eye tracking, but to a limited extent, include feedback and error handling. Criteria that would be difficult to ascertain from eye tracking include interface compatibility, and locus of control. The above should provide general guidelines, but should not be blindly used. Specific interface features and eye tracking details will certainly modify these generalities.

This study has addressed an important, yet largely overlooked topic. Although limited in context, study findings provided additional insights for hospitality researchers to further investigate the hotel decision making process. Hotel practitioners would also find the results useful for them to plan how to evaluate and interpret their hotel’s search results. Only theoretical analysis presented in this paper so the study paves the way for future empirical works towards testing the method’s efficacy. Further research using a more comprehensive measures of eye tracking would be necessary. Also, it also should focus on more specific metrics of eye movement that directly preceded the specific hotel search process.
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Kim, T. & Jung, B.(2014). The Effect of Social Network Services among Trust, Guest


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호텔 검색 프로세스에서 사용자의 시각적 주의와 행동에 관한 탐색적 연구

홍 정화*

요 약

오늘날의 인터넷은 여행 정보를 검색하고 휴가 예약을 하는 데에 있어 많은 이용자가 가장 선호하는 채널로 보고되고 있다. 온라인 환경에서 단순한 컴퓨터 작업으로 많은 양의 정보를 검색할 수 있기 때문에 사용자의 시각적 주의와 행동은 매우 중요한 의미를 가진다. 웹 검색 중 이미지, 색채, 정보의 양 등 많은 방해 요인들로 인해 온라인 소비자의 정확한 의사결정과정을 파악하기는 곤란하다. 게다가 다른 상품 구매와 달리 호텔상품과 관련된 온라인 의사결정과정은 더 복잡하고 더 많은 인지요구를 필요로 하는 것으로 알려져 있다.

이 연구는 인터넷에서의 호텔 검색에 있어 사용자의 의사결정과정의 복잡성을 탐구하였다. 호텔 검색 프로세스에서 사용자의 시각적 주의와 행동을 어떻게 평가할 것인가를 논의하였다. 또한, 인간 컴퓨터 상호작용(HCI)과 유용성 연구의 맥락에서 아이 트래킹(eye tracking)의 사용성을 증명하였다. 이로서 정보 탐색 과정에 있어 다양한 아이 트래킹 분석과 과정에 대한 실질적인 가이드를 제공하였다.

주제어: 인간 컴퓨터 상호작용(HCI), 아이 트래킹, 시각적 주의와 행동, 호텔 검색 프로세스

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