COMPUTER ENGINEERING PROGRAM

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Correlation Between Scanpaths and Visual Elements of Web Pages

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eMINE scanpath algorithm was developed in order to identify common scanpaths in terms of visual elements of Web pages. It was integrated with the Vision Based Page Segmentation (VIPS) algorithm, which was improved and extended as part of eMINE project, on the ACTF platform. Once the areas of interests are created using the VIPS algorithm, eye tracking data can be imported to identify common scanpaths. To evaluate eMINE scanpath algorithm, an eye tracking study was conducted. This study shows that this algorithm is able to successfully identify common scanpaths. It also investigated that the gender and Web page familiarity affects the common scanpaths. This algorithm can be improved in the future by considering different techniques for the pre-processing of the data, by addressing the drawbacks of using the hierarchical structure and by taking into account the underlying cognitive processes.

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The World Wide Web (web) has moved from the Desktop and now is ubiquitous. It can be accessed by a small device while the user is mobile or it can be accessed in audio if the user cannot see the content, for instance visually disabled users who use screen readers. However, since web pages are mainly designed for visual interaction; it is almost impossible to access them in alternative forms. Our overarching goal is to improve the user experience in such constrained environments by using a novel application of eye tracking technology. In brief, by relating scanpaths to the underlying source code of web pages, we aim to transcode web pages such that they are easier to access in constrained environments.

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1 Introduction

The World Wide Web (Web) can be accessed by different devices with different requirements and constraints. For example, many people access the Web using their small screen devices while they are mobile and visually disabled people typically access the Web using screen readers. Since Web pages are mainly designed for visual interaction, it is difficult to access them in alternative forms [12].

When people access Web pages with their small screen devices, they can experience many difficulties [26]. For example, when people access the Web with their small screen devices, only some parts of Web pages or whole Web pages with very small text size can be seen on their device screens. Thus, they may need to scroll or zoom a lot which can be annoying. In addition, they may need more time and efforts to find their targets. Figure 1 illustrates how the 13th International Conference on Web Engineering (ICWE'13) home page is shown on the small screen device iPhone5 as an example. This example clearly illustrates the need of scrolling and zooming on small screen devices. Because of the limited memory and processing capacities, it might be costly to download long and complex pages for most small screen devices, too [26].

Figure 1: The ICWE'13 home page on iPhone5

Web experience can also be challenging for visually disabled users [31]. As screen readers follow the source code of Web pages, visually disabled people have to listen to unnecessary clutter to get to the main content [31]. The home page of the ICWE'13 can be used to illustrate the problems of screen readers. In order to simulate how screen readers read the Web page, we used aDesigner [1] which has been developed by IBM to ensure that

[1]`http://www.eclipse.org/actf/downloads/tools/aDesigner/`

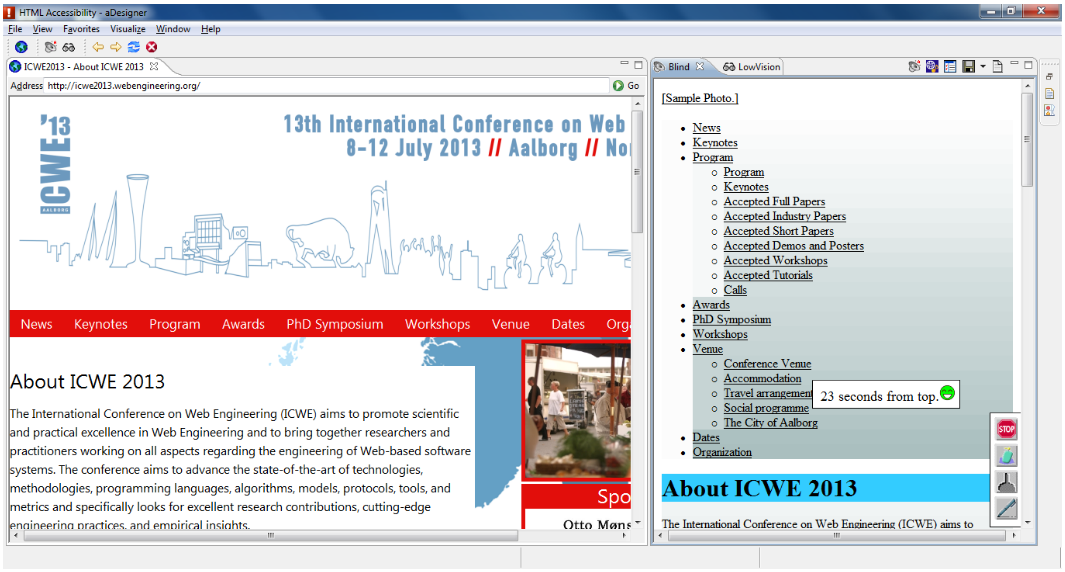

Figure 2: The aDesigner's simulation of how the screen readers read the ICWE'13 home page

Web pages are accessible to visually disabled people (see Figure 2). Screen readers start to read this page from "Sample Photo" and then read the menu item by item (News, Keynotes, Program, Program, Keynotes and so on). An inappropriate word "Sample Photo" is read by screen readers because the Web page's header is an image and its alternative text is set to "Sample Photo". Furthermore, although it is possible to skip some chunks, visually disabled people have to listen to unnecessary clutter to get to the main content. For example, if users want to access the accommodation information, they have to wait for 23 seconds to find the related link. After they read about the accommodation, if they want to get information about the social program, they have to listen to the menu item by item again for 25 seconds to find the related link.

To address these problems Web page transcoding has been proposed. Transcoding is a technique used to re-engineer Web pages to make them more accessible [5]. The existing studies show that the transcoding techniques improve disabled and small screen device users' experience on the Web using different ways such as reordering the content [19] and removing irrelevant or repetitive content [19, 31]. However, it is clear that a good transcoding technique depends on a good understanding of structure, content and context of use [29]. Unfortunately, not many of these studies try to understand how Web pages are used in reality to do transcoding. We believe eye tracking is a good way of achieving that.

The overarching goal of eMINE project is to improve the user experience in such constrained environments by using a novel application of eye tracking technology. Eye tracking has widely been used to investigate cognitive processes for over 30 years [24], but it is relatively a new area in the Web use [15]. While reading, eyes make quick movements which are called saccades [23]. Between saccades, eyes make fixations where they become relatively stationary [23]. Both fixations and saccades create scanpaths which are eye movement sequences [23]. Figure 3 illustrates a scanpath on a segmented Web page. The cycles represent fixations where the larger cycles represent longer fixations. The numbers in these

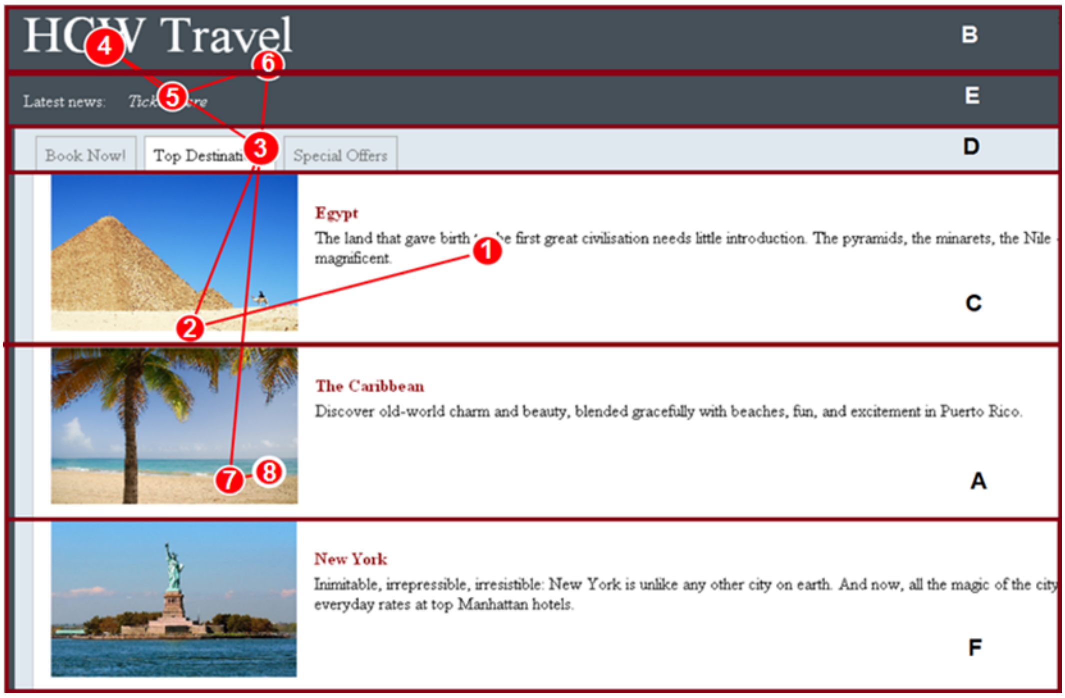

Figure 3: Scanpath on a segmented Web page

cycles show the sequence. In addition, the lines between cycles are saccades.

We believe eye tracking will allow us to drive Web page transcoding by providing a better understanding of a users' experience and enabling the prediction of future interactions. Firstly, it should be understood how sighted users read Web pages on desktop screens. Web pages can then be transcoded to improve the user experience. We assert that both visually disabled and mobile users would benefit from such development. Most mobile operators are also interested in transforming Web pages before they are served to end user [2], so the results would be beneficial for mobile operators. Moreover, this project will provide benefits for designers, engineers, and practitioners working on Web accessibility and the mobile Web.

In order to make Web pages more accessible for a wide range of people, we are interested in transcoding based on common patterns in eye tracking data instead of individual patterns. However, there is not much research in identifying common scanpaths. The conventional Dot-plots algorithm [11] and eyePatterns's discover patterns technique [28] are two examples which are trying to identify common scanpaths. However, these algorithms are reductionist which means they are likely to produce unacceptable short scanpaths. Moreover, they tend to ignore the complexities of underlying cognitive processes: when one follows a path to achieve a task, there is a reasoning that affects their decision, and none of these algorithms capture that. Besides, they simply accept string representations of scanpaths without analysing eye tracking data. Since eye trackers collect a large amount of data, pre-processing should be applied by considering eye tracking metrics, such as fixation duration, to improve the quality of data. For example, very short fixations, which have no meaning, can be removed [25, 27]. Unfortunately, most of the algorithms do not focus

[2]http://www.w3.org/TR/ct-guidelines/

on eye tracking metrics. Detailed information about the problems of the existing scanpath analysis methods can be found in the Deliverable 5 [10].

Our current work aims to address the problems of the existing scanpath analysis methods. However, in the scope of eMINE project we focused on the problem being reductionist. We developed eMINE scanpath algorithm that takes a number of scanpaths and returns a pattern that is common in all scanpaths - that means we are trying to identify a route in terms of visual elements of Web pages followed by people [10].

The **purpose** of this technical report is to explain how eMINE scanpath algorithm was implemented and evaluated. First of all, it gives the details about the implementation of eMINE scanpath algorithm - how the algorithm was implemented and how the algorithm was integrated with the Vision Based Page Segmentation (VIPS) algorithm, which was improved and extended as part of eMINE project (Section 2). It is also demonstrated step by step with an example (Section 2). The validity and scalability of eMINE scanpath algorithm was experimentally evaluated with an eye tracking study. The effect of gender, familiarity, complexity and segmentation granularity was investigated, too. This technical report explains the methodology used to evaluate the algorithm (Section 3). It also provides the results and discussions (Section 4 and 5). Finally, it concludes the report by providing a brief summary and some suggestions for future improvements for eMINE scanpath algorithm based on the evaluation (Section 6).

2 eMINE Scanpath Analysis Algorithm

This section starts with brief description of eMINE scanpath analysis algorithm which can be called eMINE scanpath algorithm. After that, it discusses the technologies used to implement this algorithm. This section also provides the system architecture to illustrate how this algorithm relates to the extended and improved version of the Vision Based Page Segmentation algorithm [1]. Finally, it gives a demonstration of how the system works.

2.1 eMINE Scanpath Algorithm

Algorithm 1 shows our proposed eMINE scanpath algorithm which takes a set of scanpaths and return a scanpath which is common in all the given scanpaths. If there is only one scanpath, it returns that one as the common scanpath, if there is more than one, then it tries to find the most similar two scanpaths in the given list. It does this by using the Levenshtein Distance which is the traditional String-edit algorithm [15]. Then it removes these two scanpaths from the given list of scanpaths and introduces their common scanpath to the list of scanpaths given originally. This continues until there is only one scanpath.

Algorithm 1 Find common scanpath

```
Input: Scanpath List
Output: Scanpath
if the size of Scanpath List is equal to 1 then
    return the scanpath in Scanpath List
end if
while the size of Scanpath List is not equal to 1 do
    Find the two most similar scanpaths in Scanpath List with the Levenshtein Distance
    Find the common scanpath by using Longest Common Subsequence
    Remove the similar scanpaths from the Scanpath List
    Add the common scanpath to the Scanpath List
end while
return the scanpath in Scanpath List
```

2.2 System Architecture

eMINE scanpath algorithm was integrated with the extended and improved version of the VIPS algorithm [1]. Figure 4 illustrates the system architecture. It consists of the following parts: two input parts (Web page and eye tracking data), three functional parts (Web page Area of Interest (AoI) identification, an application to create string representations of scanpaths, eMINE scanpath algorithm), two intermediate parts which are created as an output of one functional part and used as an input for another functional part (Web page AoIs, string representations of scanpaths) and one output part (Common scanpath). The functional parts are explained below.

Web Page AoI Identification A Web page is used as an input for the Web page AoI identification part. This part creates AoIs automatically by using the extended and improved version of the VIPS algorithm which is a well-known Web page segmentation

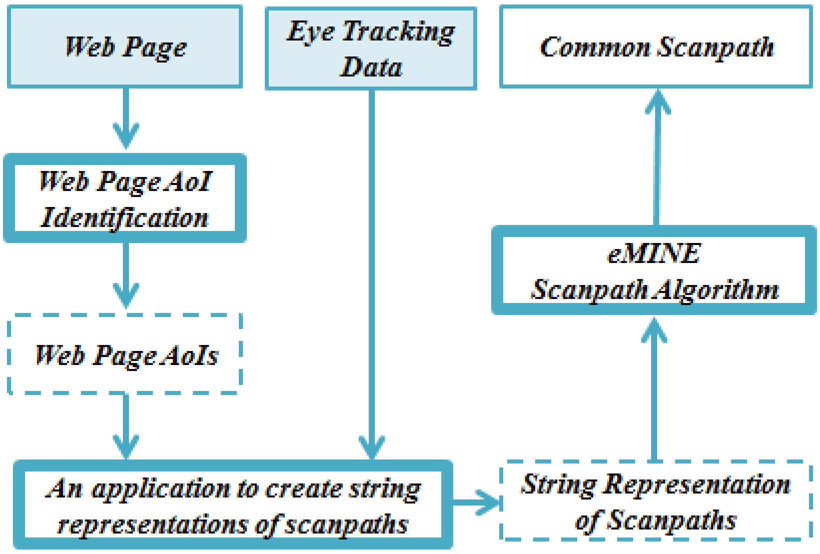

Figure 4: System architecture

algorithm which uses the structural information provided in HTML DOM and visual presentation [7, 1]. Even though, the extended VIPS was used, it would be easily replaced by an alternative method of AoI identification approach.

An Application to Create String Representations of Scanpaths The automatically generated Web page AoIs and eye tracking data are then used by an application to create abstracted string representations of scanpaths. String representations of scanpaths are sequences of AoIs which are followed by people. In order to have abstracted string representations of scanpaths, their string representations are simplified by abstracting consecutive repetitions [6, 13]. For example, AABBBCCCCC becomes ABC.

eMINE Scanpath Algorithm Once the abstracted string representations are created, our scanpath algorithm is applied to them to produce a common scanpath in terms of AoIs.

2.3 Implementation Details

eMINE scanpath algorithm was implemented using Java programming language on the Accessibility Tools Framework (ACTF) which is an open-source Eclipse project. This framework is defined as "an extensible infrastructure upon which developers can build a variety of utilities that help to validate and enhance the accessibility of applications and content for people with disabilities" [3]. Many applications are available on this platform. For example, ViCRAM tool which is able to calculate the complexities of Web pages was implemented on this platform [21]. In addition, aDesigner [4] which ensures that Web pages are accessible to visually disabled people was also implemented by IBM on this platform.

[3] http://www.eclipse.org/actf/
[4] http://www.eclipse.org/actf/downloads/tools/aDesigner/

2.4 Demonstration

The system is demonstrated below with eight steps. Assume that a user wants to find a common scanpath in terms of AoIs on the Apple Web page. When the user runs the system and enters the URL of the Apple Web page, he or she sees the main screen shown in Figure 5.

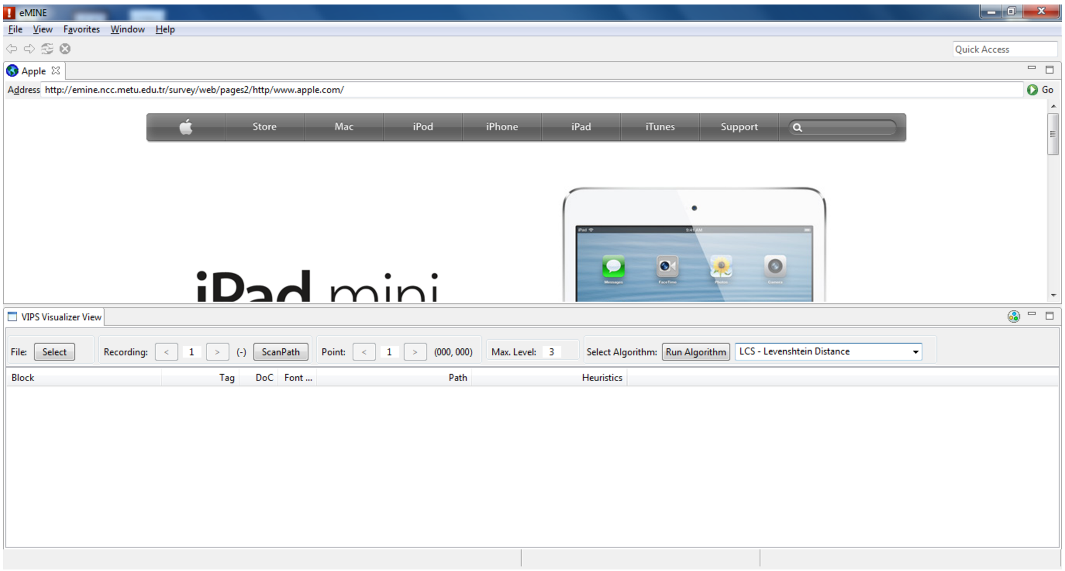

Figure 5: eMINE scanpath algorithm demonstration: Step 1

Once the Apple Web page is successfully loaded, he or she can import the eye tracking datasets in CSV format by selecting them from the related directory as shown in Figure 6. The user also needs to enter the page name to retrieve the related records from the eye tracking datasets (see Figure 7). Moreover, the user is able to filter the data using the fixation duration as shown in Figure 8.

When the eye tracking data is successfully imported to the system, the user can segment the Web pages into blocks, namely AoIs, as shown in Figure 9. The segmentation is done by using the extended and improved version of the VIPS algorithm [1]. Detailed information about the segmentation can be found in the Deliverable 2 [1].

Since the system already knows automatically generated AoIs widths, heights, x and y coordinates from the VIPS algorithm, it can easily detects which AoIs the fixations are located using the x and y coordinates of fixations. Next, the fixations get the names of their AoIs to create the string representations. To prevent complexity, the AoI names is replaced with a single character such as A and B. In addition, the string representations are simplified by abstracting consecutive repetitions. These representations are called as abstracted string representations. When the user clicks on “Run Algoritm” to run eMINE scanpath algorithm, a window appears to show the real AoI names and their simplified name as shown in Figure 10. For example, the simplified name of the AoI V.B.1.2.1.1.2.2 is C.

When a common scanpath is identified, it is shown in a message box (see Figure 11). Here, ABAACC is produced as a common scanpath where A means V.B.1.2.1.2, B means V.B.1.1.2 and C means V.B.1.2.1.1.2.2. These AoIs can be viewed by selecting them in the segmentation tree as shown in Figure 12. The common scanpath is also exported in

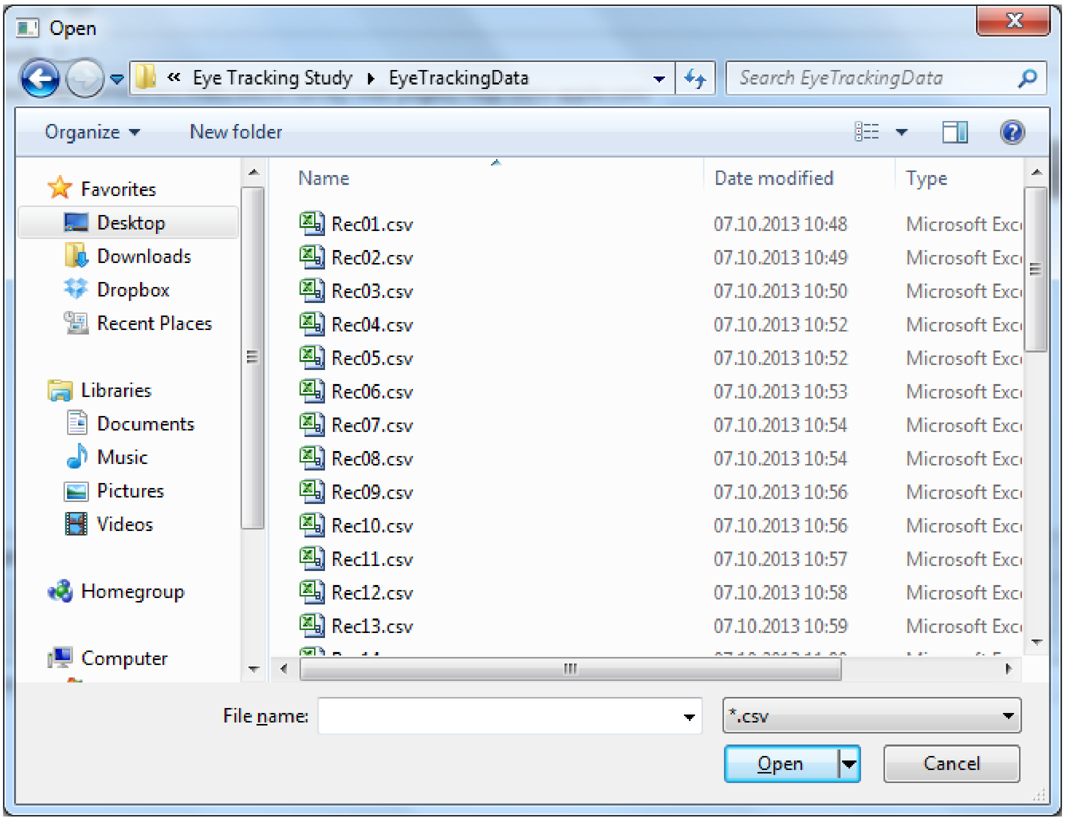

Figure 6: eMINE scanpath algorithm demonstration: Step 2

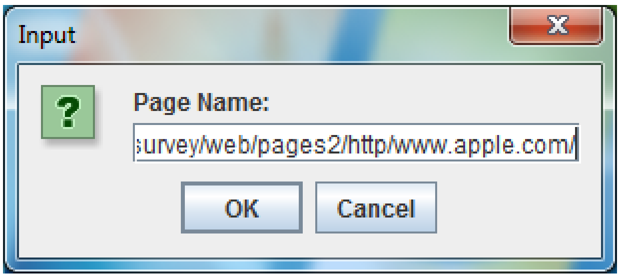

Figure 7: eMINE scanpath algorithm Demonstration: Step 3

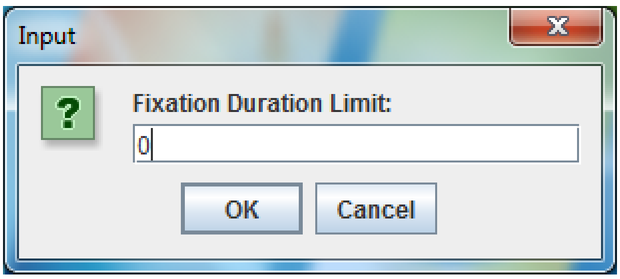

Figure 8: eMINE scanpath algorithm demonstration: Step 4

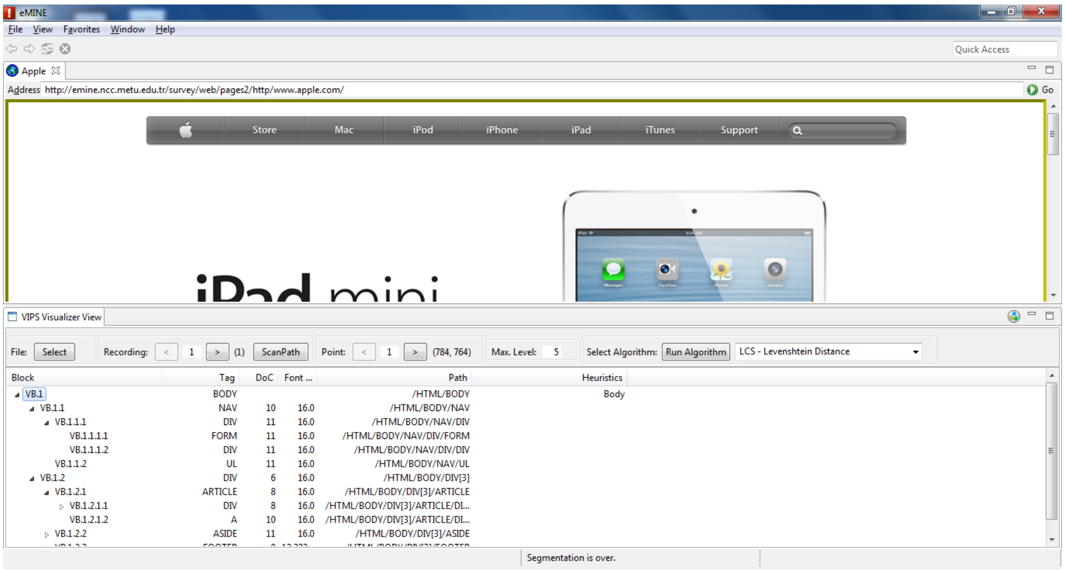

Figure 9: eMINE scanpath algorithm demonstration: Step 5

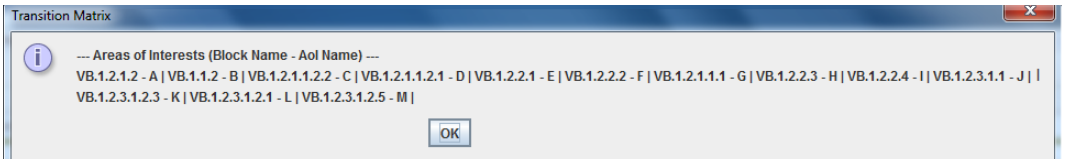

Figure 10: eMINE scanpath algorithm demonstration: Step6

JSON format in terms of visual blocks the extended VIPS algorithm produces as shown in Figure 13 [1].

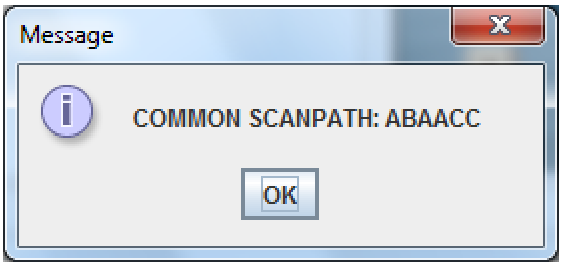

Figure 11: eMINE scanpath algorithm demonstration: Step 7

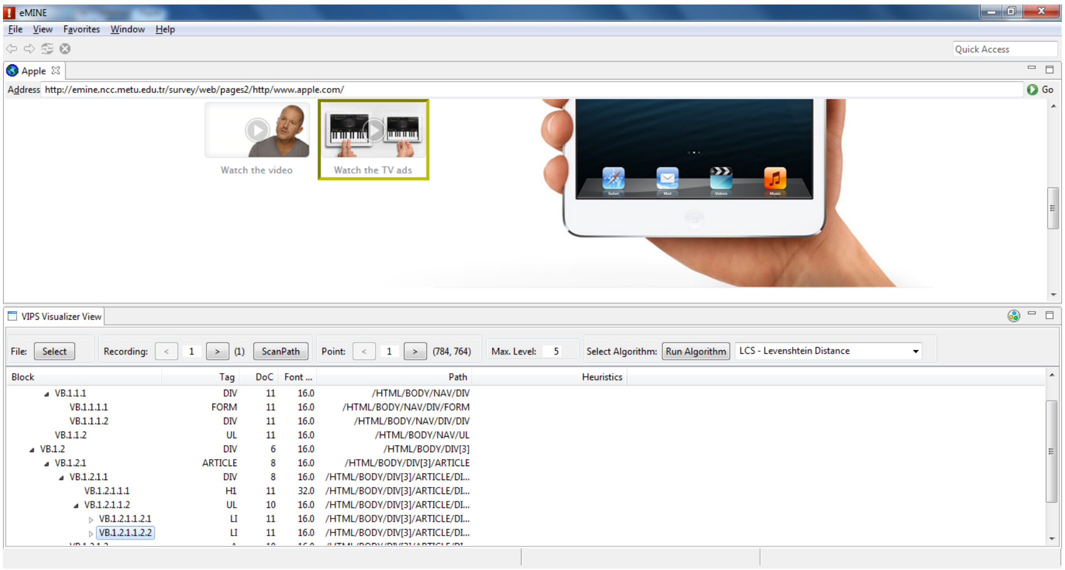

Figure 12: eMINE scanpath algorithm demonstration: Step 8


```
{
    "main_path": ["VB.1.2.1.2",
                  "VB.1.1.2",
                  "VB.1.2.1.2",
                  "VB.1.2.1.2",
                  "VB.1.2.1.1.2.2",
                  "VB.1.2.1.1.2.2"]
}
```


Figure 13: eMINE scanpath algorithm demonstration: Step 9

3 Experimental Plan

Our main goal is to experimentally evaluate validity and scalability of eMINE scanpath algorithm, and to investigate the effect of gender, familiarity, complexity and segmentation granularity. For this purpose we explore the following.

1. *Validity:*We aim to test eMINE scanpath algorithm to see whether or not it can successfully identify common scanpaths in terms of visual elements of Web pages. Thus, we need to ask **"Can eMINE algorithm identify common scanpaths in terms of visual elements of Web pages?"**.

2. *Scalability:* Our pilot study explained in the Deliverable 5 illustrated that eMINE scanpath algorithm is able to identify a common scanpath for 10 participants in terms of visual elements on the HCW Travel Web page [30, 10]. We would like to test eMINE scanpath algorithm with more participants on different Web pages to see whether or not it works well for different numbers of participants. Hence, the research question here is **"How does the number of individual scanpaths affect common scanpaths?"**.

3. *Gender Effect:* Some studies show that gender can affect heat maps on some specific Web sites [4]. We would like to test eMINE scanpath algorithm to see whether or not the gender causes differences in common scanpaths. Therefore, we ask the following research question: **"How does the gender affect common scanpaths?"**.

4. *Familiarity Effect:* In a study conducted by Mccarthy et al. (2003), the participants were asked to complete a number of tasks on the Web pages where a main menu was located at different locations: on the left, on the right and at the top. Since the participants expected to see a main menu on the left, they completed the tasks earlier on the page whose main menu was on the left. Thus, we would like to consider Web page familiarity to see whether or not the familiarity can affect common scanpaths. We investigate the following research question: **"How does the Web page familiarity affect common scanpaths?"**.

5. *Complexity Effect:* The study conducted by Michailidou (2010) suggests some Web pages may have simpler or more complex structure compared to others. Michailidou (2010) also provides a tool, ViCRAM, to determine complexities of Web pages based on their structures. Therefore, we will test eMINE scanpath algorithm on Web pages which have different level of complexity. The research question here is **"How does the Web page complexity impact common scanpaths?"**.

6. *Segmentation Granularity Effect:* Web pages can be segmented in different levels. For example, the extended VIPS algorithm is able to segment Web pages in different levels where Level 1 can produce larger segments (i.e., AoIs) whereas Level 5 can produce quite smaller segments [1]. Therefore here we are interested to see if that has any effect on the common scanpath. The research question here is **"How does the segmentation granularity impact common scanpaths?"**.

3.1 Equipment

Participants sat in front of a 17" monitor with a built in TOBII T60 eye tracker with screen resolution 1280 x 1024. The Web pages was on a HP ELiteBook 8530p laptop and these Web pages were shown to the participants using the eye tracker's screen. Tobii Studio eye gaze analysis software was used to record the data. Eye tracking data was also stored on that laptop, too. The collected eye tracking data were analysed on a 17" monitor with the screen resolution 1280 x 1024.

3.2 Materials

Since we are interested in identifying common scanpaths in terms of visual elements of Web pages, we chose six different Web pages were randomly selected from a previous study which focused on identifying visual elements of Web pages [2]. These Web pages were categorised according to their complexity, which were low, medium and high [2, 21]. Two Web pages were chosen randomly from each level of complexity for our study. Since the 5th segmentation granularity level was found as the most successful level with approximately 75% user satisfaction, we decided to use the 5th level for our experiments [3]. These segmented Web pages with their level of complexity are shown in Figure 14, 15, 16, 17, 19 and 18.

Figure 14: Apple (Complexity: Low)

3.3 Procedure

We designed and conducted an eye tracking study which includes the following three main parts:

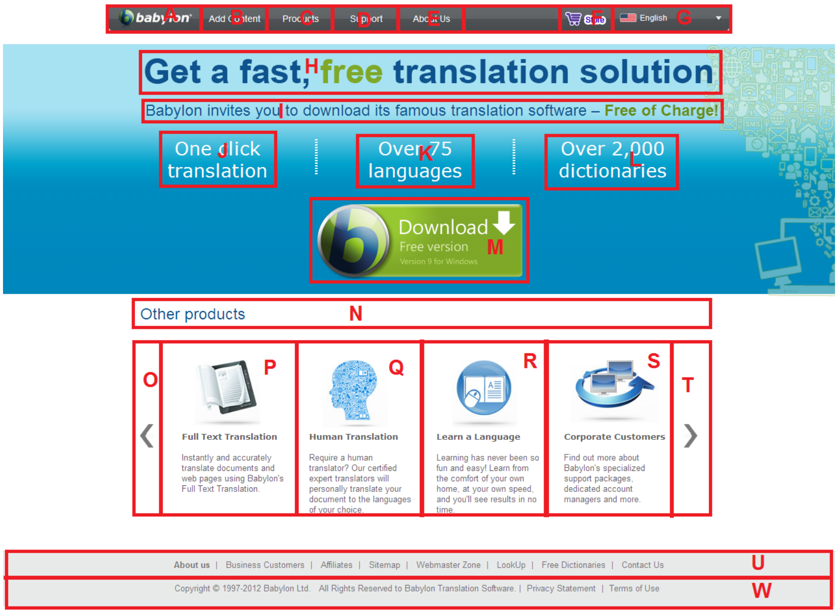

Figure 15: Babylon (Complexity: Low)

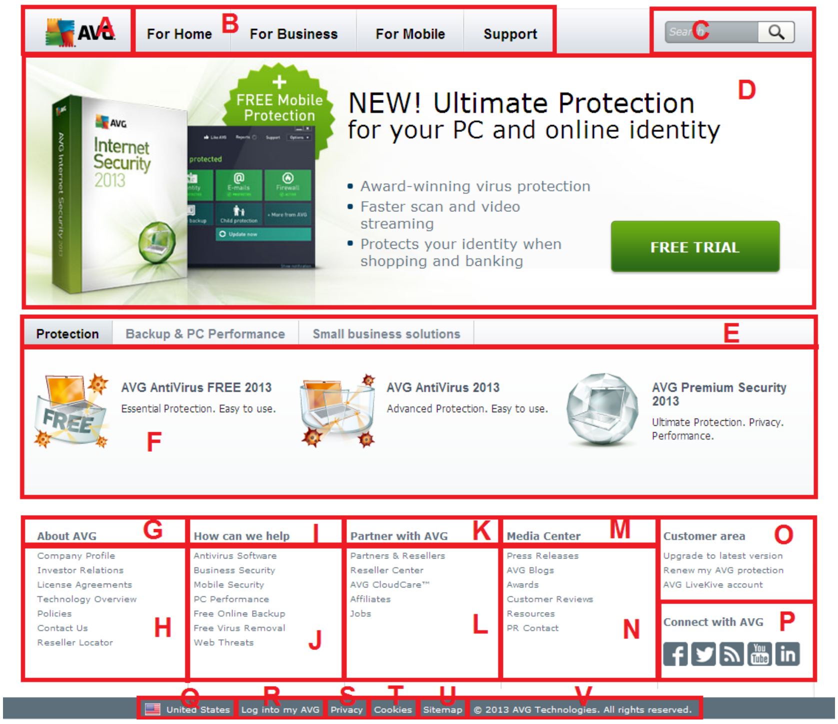

Figure 16: AVG (Complexity: Medium)

Figure 17: Yahoo (Complexity: Medium)

Figure 18: GoDaddy (Complexity: High)

Figure 19: BBC (Complexity: High)

1. *Introduction:* The participants read the information sheet and signed the consent form (see Appendix A). Next, they filled in the short questionnaire which was for the purpose of collecting basic demographic information of participants, which are gender, age groups and education level. The participants were also asked to rank their Web page usage for the six Web pages between 1 (daily) and 5 (never) (see Appendix B).

2. *Main Part:* The participants sat in front of the eye tracker which calibrated to their gaze. They then viewed all of the six Web pages twice, one view for searching (maximum 120 seconds) and one view for browsing (30 seconds each) in a random order. The searching and browsing tasks are shown in Table 1. For browsing tasks, the participants were given 30 seconds as used in other studies [14, 22]. The researcher was responsible to check if the participants complete the tasks successfully and take required notes.

3. *Conclusion:* At the end, the participants were asked to redraw three Web pages from three different complexity level.

3.4 User Tasks

User tasks are categorised into two groups for this study: searching and browsing. In the literature, many studies were conducted to categorise users task on the Web [17, 18, 16, 20]. G. Marchionini Search Activities Model is one of the most popular models in this field [20]. It consists of three groups which are lookup, learn and investigate [20]. Our searching category is related to fact finding which is associated with the lookup group whereas our brows-

Apple	
Browsing	1. Can you scan the Web page if you find something interesting for you?
Searching	1. Can you locate a link which allows watching the TV ads relating to iPad mini? 2. Can you locate a link labeled: iPad on the main menu?
Babylon	
Browsing	1. Can you scan the Web page if you find something interesting for you?
Searching	1. Can you locate a link you can download the free version of Babylon? 2. Can you find and read the names of other products of Babylon?
Yahoo	
Browsing	1. Can you scan the Web page if you find something interesting for you?
Searching	1. Can you read the titles of the main headlines which have smaller images? 2. Can you read the first item under News title?
AVG	
Browsing	1. Can you scan the Web page if you find something interesting for you?
Searching	1. Can you locate a link which you can download a free trial of Internet Security 2013? 2. Can you locate a link which allows you to download AVG Anti virus FREE 2013?
GoDaddy	
Browsing	1. Can you scan the Web page if you find something interesting for you?
Searching	1. Can you find a telephone number for technical support and read it? 2. Can you locate a text box where you can search a new domain?
BBC	
Browsing	1. Can you scan the Web page if you find something interesting for you?
Searching	1. Can you read the first item of Sport News? 2. Can you locate the table that shows market data under Business title?

Table 1: Tasks used in the eye tracking study

ing category is related to serendipitous browsing which is associated with the investigation group. The tasks which are defined for the six Web pages are listed in Table 1.

We designed the system to ensure that half of the participants complete searching tasks firstly and then complete browsing tasks. Other half completed browsing task firstly and then completed searching tasks. The reason is to prevent familiarity effects on eye movements which can be caused by the user tasks.

3.5 Participants

The majority of the participants comprised students, along with some academic and administrative staff at Middle East Technical University Northern Cyprus Campus and the University of Manchester. Twenty male and twenty female volunteers participated.

One male participant changed his body position during the study, so the eye tracker could not record his eye movements. Another male participant had no successful eye calibration. Unfortunately, these two participants were excluded from the study. Therefore, the eye tracking data of 18 males and 20 females were used to evaluate eMINE scanpath algorithm.

All of the participants use the Web daily. Figure 20 shows the age distribution of the participants. Most of the participants (18 participants) are aged between 18 and 34 years old, then 25-35 group (14 participants) and 35-54 group (6 participants). However, there are 6 participants who are between 35 and 54 years old.

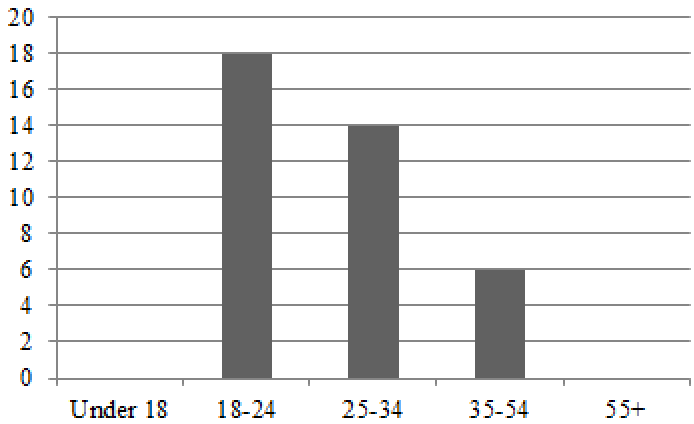

Figure 20: Age groups of the participants

As shown in Figure 21, there were 14 participants who completed their high/secondary schools, 6 participants who had a bechelor's degree, 9 participants who had a master's degree and 9 participants with a doctorate degree.

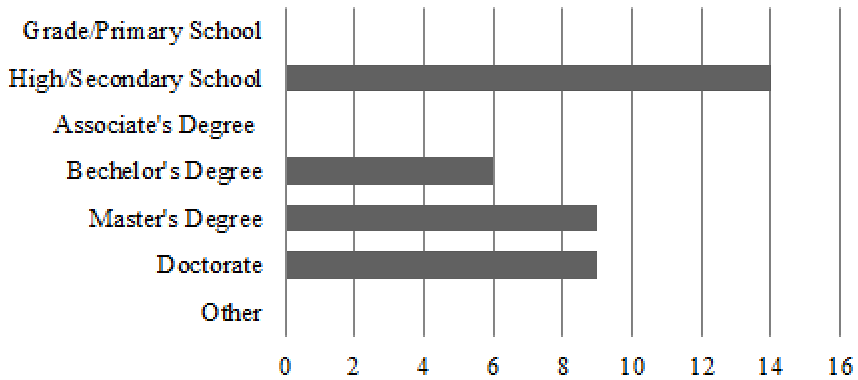

Figure 21: Educational background of the participants

4 Results

This section provides the results of our experiments based on our research goals and questions (see Section 3).

4.1 Validity

"Can eMINE scanpath algorithm identify common scanpaths in terms of visual elements of Web pages?"

Besides browsing tasks, the participants were asked to complete some searching tasks on Web pages, therefore we are expecting to see that the common scanpath supports those tasks. We used eMINE scanpath algorithm to identify a common scanpath for each of the six Web pages. We excluded the participants who could not complete the searching tasks successfully. Table 2 shows the common scanpaths produced by eMINE scanpath algorithm for the Web pages.

Page Name	Number of Participants	Common Scanpath
Apple	31	E
Babylon	36	MMPQRS
AVG	36	DFDF
Yahoo	29	E
Godaddy	34	POO
BBC	38	M

Table 2: The common scapaths produced by eMINE scanpath algorithm for the Web pages

On the Apple Web page, 31 out of 38 participants completed the task successfully. On this page, the participants were asked to locate a link which allows watching the TV ads relating to iPad mini and then locate a main menu item "iPad". E is identified as a common scanpath for these participants. Since E is associated with the first part of the searching task, the common scanpath partially supports the searching task. Figure 22 shows this common scanpath on the Apple Web page. As can be seen from this figure, the fixations are located in the related AoI randomly. In addition, the diameter of the fixations, which normally should be related to fixation duration, are the same because eMINE scanpath algorithm does not take the fixation duration into account while identifying common scanpaths. The purpose here is only to show the sequence.

On the Babylon Web page, only two people out of 38 could not complete the task successfully. On this page, the participants were requested to locate a link which allows downloading a free version of Babylon and then read names of other products of Babylon. The common scanpath for 36 participants was identified as MMPQRS shown in Figure 23. M is related with a free version of Babylon whereas P, Q, R and S are associated with four other products of Babylon. Therefore, the common scanpath supports the searching task. When we generated a transition matrix (see Appendix C), we can see that the transition probability between M and P is 5.9 % whereas the maximum transition probability for M is 17.7 % and it is between M and J. The transition matrix also shows that when the participant

Figure 22: The common scanpath on the Apple Web page

looks for P, they are likely to look for Q (40.4 %), then R (39.8 %), and then S (38.9 %). Hence, the common scanpath is also supported with the transition matrix.

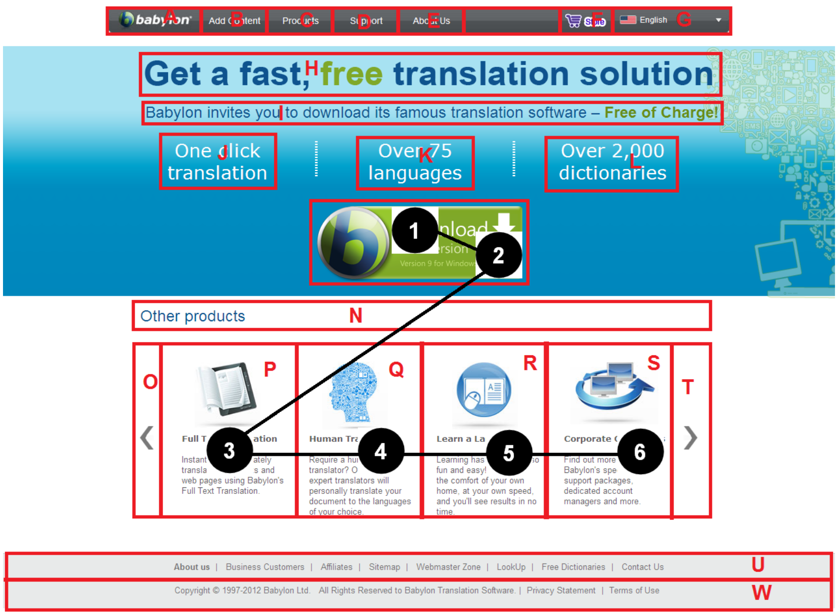

Figure 23: The common scanpath on the Babylon Web page

Similar to the Babylon Web page, only two people could not complete the task on the

AVG Web page. The searching task here was locating a link which allows downloading a free trial of AVG Internet Security 2013 and then locating a link which allows downloading AVG Anti virus FREE 2013. The common scanpath was produced as DFDF where D has a link to download a free trial of AVG Internet Security 2013 and E contains a link to download AVG Anti virus FREE 2013. Therefore, the common scanpath, shown in Figure 24, completely supports the searching task. The transition matrix (see Appendix D) for these participants illustrates that the participants are likely to look for F after D (57.3 %). Likewise, the participants are likely to look for D after F (61.4 %). Hence, the transition matrix also supports the common scanpath.

Figure 24: The common scanpath on the AVG Web page

For the Yahoo Web page, 9 participants could not complete the searching task. The success rate in completing searching tasks is 76.32 % and it the lowest compared to other five Web pages (Apple: 81.58 %, Babylon: 94.74 %, AVG: 94.74 %, Godaddy: 89.47 % and BBC: 100 %). The participants required to read the titles of the main headlines which have smaller images and then read the first item under News title. Since E is produced as a common scanpath on this Web page and E contains both parts of the task, the common scanpath supports the searching task, too. Figure 25 shows this common scanpath.

Since 34 out of 38 participants completed the tasks successfully, 4 participants were excluded. The successful participants read the telephone number for technical support and then located a search box where they can search for a new domain. eMINE scanpath algorithm produced POO as a common scanpath shown in Figure 26. Since O contains the search box and there is no AoI in the scanpath which is related with the telephone number, the common scanpath partially supports the searching task on the Godaddy Web page.

Figure 25: The common scanpath on the Yahoo Web page

Figure 26: The common scanpath on the Godaddy Web page

On the BBC Web page, all participants completed the searching task successfully. The participants were asked to read the first item of the sports news and then locate a table which shows the market data. Therefore, the participants needed to locate AoI M. As the common scanpath M is produced, it supports the searching task. Figure 27 illustrates this common scanpath on the BBC Web page.

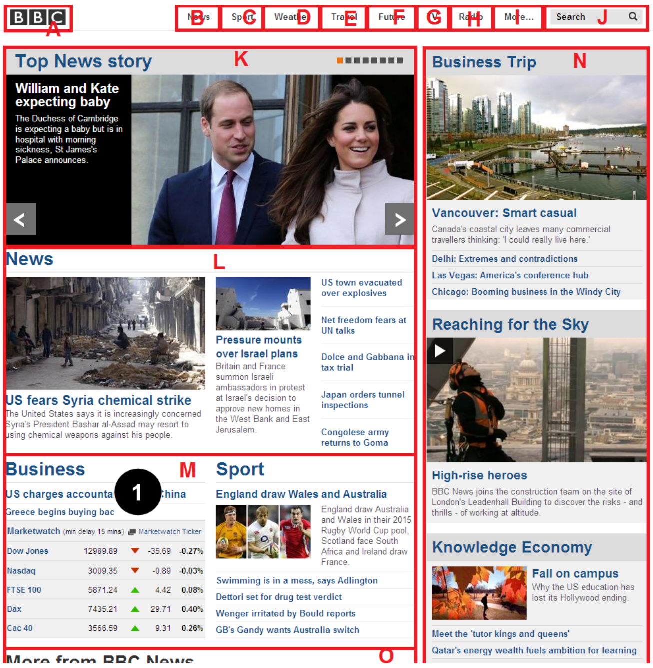

Figure 27: The common scanpath on the BBC Web page

The common scanpaths on the Babylon, AVG, Yahoo and BBC Web pages support the searching tasks whereas the common scanpaths on the Apple and Godaddy Web pages partially support the searching tasks.

4.2 Scalability

"How does the number of individual scanpaths affect common scanpaths?"

In order to test whether or not eMINE scanpath algorithm works well with different numbers of individual scanpaths, we tested the algorithm with different numbers of individual participants. The participants were selected randomly from all of the participants. Table 3 illustrates the common scanpaths in terms of AoIs on the different Web pages for 10, 20, 30 and 30+ participants while browsing and searching. Note that there is no more than 29 participants who completed the searching task successfully on the Yahoo Web page, so the common scanpaths for 30 and 30+ participants are not available. These AoIs in the common scanpaths refer to AoIs on the related Web pages shown in Figure 14, 15, 16, 17, 19 and 18.

In order to see how the common scanpaths are affected when the number of participants increases, we calculated the similarities between the scanpaths which were produced for 10,

Task	Page Name	Complexity	P=10	P=20	P=30	P=30+
Browsing	Apple	Low	CFFHF	CFIF	F	CF
	Babylon	Low	MMPP	MM	M	M
	AVG	Medium	DDFPDD	DFDF	DD	DD
	Yahoo	Medium	EDED	EDDEE	EED	EED
	Godaddy	High	PPRPPP	PPRPP	PPRP	PPRP
	BBC	High	KLN	KLN	KLN	NN
Searching	Apple	Low	FFEF	EEA	E	E
	Babylon	Low	MMPPQRS	MMPQRS	MMPQRS	MMPQRS
	AVG	Medium	DFDFDFD	DFDF	DFDF	DFDF
	Yahoo	Medium	DEDE	E		
	Godaddy	High	POPOP	POOO	PO	POO
	BBC	High	MNMNM	NMNMNM	MNM	M

Table 3: The common scanpaths on the different Web pages for 10, 20, 30 and 30+ participants while browsing and searching

20, 30 and 30+ participants. For example, on the Apple Web page the similarity between the common scanpaths for the browsing task for 10 and 20 participants is equal to 60 % as shown in Table 4

Apple Browsing	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	60	20	40
P = 20	60	—	25	50
P = 30	20	25	—	50
P = 30+	40	50	50	—

Table 4: The similarities between the common scanpaths on the Apple Web page for 10, 20, 30 and 30+ participants while browsing

Table 5- 15 shows these similarities for all of the Web pages for both the browsing and searching tasks.

Babylon Browsing	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	50	25	25
P = 20	50	—	50	50
P = 30	25	50	—	100
P = 30 +	25	50	100	—

Table 5: The similarities between the common scanpaths on the Babylon Web page for 10, 20, 30 and 30+ participants while browsing

For both the browsing and searching tasks, we calculated the average similarity between the common scanpaths on each Web page. To calculate these average similarities, we divided the sum of the similarities between the scanpaths for 10, 20, 30 and 30+ participants by the total number of the similarities. In addition, we calculated the average similarity for both the browsing and searching tasks. Since each Web page typically has four scanpaths (for 10, 20, 30 and 30+ participants), we determined their weight based on the number of scanpaths. All of the pages have four weight, except the Yahoo page because of the search-

AVG Browsing	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	50	33.3	33.3
P = 20	50	—	50	50
P = 30	33.3	50	—	100
P = 30+	33.3	50	100	—

Table 6: The similarities between the common scanpaths on the AVG Web page for 10, 20, 30 and 30+ participants while browsing

Yahoo Browsing	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	60	75	75
P = 20	60	—	40	40
P = 30	75	40	—	100
P = 30+	75	40	100	—

Table 7: The similarities between the common scanpaths on the Yahoo Web page for 10, 20, 30 and 30+ participants while browsing

Godaddy Browsing	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	83.3	66.7	66.7
P = 20	83.3	—	80	80
P = 30	66.7	80	—	100
P = 30+	66.7	80	100	—

Table 8: The similarities between the common scanpaths on the Godaddy Web page for 10, 20, 30 and 30+ participants while browsing

BBC Browsing	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	100	100	33.3
P = 20	100	—	100	33.3
P = 30	100	100	—	33.3
P = 30 +	33.3	33.3	33.3	—

Table 9: The similarities between the common scanpaths on the BBC Web page for 10, 20, 30 and 30+ participants while browsing

Apple Searching	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	25	25	25
P = 20	25	—	33.3	33.3
P = 30	25	33.3	—	100
P = 30+	25	33.3	100	—

Table 10: The similarities between the common scanpaths on the Apple Web page for 10, 20, 30 and 30+ participants while searching

Babylon Searching	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	85.8	85.8	85.8
P = 20	85.8	—	100	100
P = 30	85.8	100	—	100
P = 30+	85.8	100	100	—

Table 11: The similarities between the common scanpaths on the Babylon Web page for 10, 20, 30 and 30+ participants while searching

AVG Searching	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	57.2	57.2	57.2
P = 20	57.2	—	100	100
P = 30	57.2	100	—	100
P = 30+	57.2	100	100	—

Table 12: The similarities between the common scanpaths on the AVG Web page for 10, 20, 30 and 30+ participants while searching

Yahoo Searching	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	25	–	—
P = 20	25	—	—	—
P = 30	—	—	—	—
P = 30+	—	—	—	—

Table 13: The similarities between the common scanpaths on the Yahoo Web page for 10, 20, 30 and 30+ participants while searching

Godaddy Searching	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	60	40	60
P = 20	60	—	50	75
P = 30	40	50	—	66.7
P = 30+	60	75	66.7	—

Table 14: The similarities between the common scanpaths on the Godaddy Web page for 10, 20, 30 and 30+ participants while searching

BBC Searching	P = 10	P = 20	P = 30	P = 30 +
P = 10	—	83.4	60	20
P = 20	83.4	—	50	16.7
P = 30	60	50	—	33.3
P = 30 +	20	16.7	33.3	—

Table 15: The similarities between the common scanpaths on the BBC Web page for 10, 20, 30 and 30+ participants while searching

ing task. The Yahoo page has one common scanpath for 10 participants and one common scanpath for 20 participants, therefore its weight is set to two. When the average is calculated, we multiplied the value with its weight to find weighted value. After that, we found the sum of the weighted value and divided it by the sum of the weights.

Page Name	Task	Average Value
Apple	Browsing	40.8
Babylon	Browsing	50
AVG	Browsing	52.8
Yahoo	Browsing	65
Godaddy	Browsing	79.5
BBC	Browsing	66.7
Average Similarity	Browsing	59.1
Apple	Searching	40.3
Babylon	Searching	92.9
AVG	Searching	78.6
Yahoo	Searching	25
Godaddy	Searching	58.6
BBC	Searching	43.9
Average Similarity	Searching	59.4

Table 16: The average of the the similarities between the common scanpaths on each Web page for 10, 20, 30 and 30+ participants

4.3 Gender Effects

"How does the gender affect common scanpaths?"

To investigate the effect of the gender on common scanpaths, we used eMINE scanpath algorithm to produce a common scanpath for each Web page for both males and females as shown in Table 17. We selected the same number of males and females to prevent the possible effects of the number of the participants. The number is differ from one Web page to another because we excluded some participants who could not complete the searching tasks. In order to make the number of the participants equal, we randomly excluded some participants.

The average similarity for the browsing tasks is equal to 50.8 % (SD: 12.8) whereas the average similarity for the searching tasks is equal to 66.1 % (SD: 26). To investigate whether or not the gender affects the length of common scanpaths, we also calculated the average (i.e., mean) and standard deviation of the length of common scanpaths for males and females on the Web pages. As shown in Table 18, the average length for the males' browsing task is shorter than the average length for the males' searching task. In contrast, the average length for the females' browsing task is slightly longer than the average length for the females' searching task.

4.4 Familiarity Effects

"How does the Web page familiarity affect common scanpaths?"

Task	Page Name	Complexity	Number of Participants	Male	Female	Similarity
Browsing	Apple	Low	18	FFF	FIHGF	40 %
	Babylon	Low	18	R	RM	50 %
	AVG	Medium	18	DFD	FDFFF	40 %
	Yahoo	Medium	18	DED	EEDE	50 %
	Godaddy	High	18	PPP	PPPP	75 %
	BBC	High	18	LN	KN	50 %
Searching	Apple	Low	15	FFEF	F	25 %
	Babylon	Low	17	MMRPPQRS	MMPQRS	75 %
	AVG	Medium	18	DFDF	FDFDF	80 %
	Yahoo	Medium	14	EDE	E	66.7 %
	Godaddy	High	17	OPOO	OPP	50 %
	BBC	High	18	KMM	KMM	100 %

Table 17: The common scanpaths on the different Web pages for males and females while browsing and searching

Task	Male	Female
Browsing	M: 2.5 SD: 0.84	M: 3.67 SD: 1.37
Searching	M: 4.33 SD: 1.86	M: 3.17 SD: 2
Both	M: 3.42 SD: 1.68	M: 3.42 SD: 1.68

Table 18: The mean (M) and standard deviation (SD) of the length of common scanpaths for males and females on the Web pages

We measured familiarity based on the user rankings. As mentioned, we asked the participants to rank the Web pages according to their usage between 1 (daily) and 5 (never). When the participant gave 1, 2 or 3 to the Web page, it means they visit the page at least once in a month. Thus, they are aware of the Web page. However, when the participants gave 4 or 5 to the Web page, it means they might visit the Web page very few times or they have never visited the Web page (see Appendix B). If the participant gave 1, 2 or 3 to the Web page, we assumed that they are familiar with the page. Otherwise, we assumed that they are not familiar. Unfortunately, we could use three Web pages, which are the Apple, Yahoo and BBC pages, to investigate the effect of the familiarity because there is less than 10 participants who were familiar with the Babylon, AVG and Godaddy pages.

Table 19 shows the common scanpaths produced for the participants who were familiar and not familiar with the Apple, Yahoo and BBC Web pages for both the browsing and the searching tasks. We also calculated the similarities between the common scanpaths to investigate the effect of familiarity. For instance, it can be seen from Table 19 that the similarity between the common scanpaths produced for the browsing task on the Babylon page for the participants who were familiar and not familiar is equal to 50%.

The average similarity for the browsing tasks is equal to 50.8 % (SD: 12.8) whereas the average similarity is equal to 66.1 % (SD: 26). To investigate whether or not the familiarity affects the length of common scanpaths, we also calculated the average (i.e., mean) and standard deviation of the length of common scanpaths for familiarity and unfamiliarity aspects as shown in Table 20. As can be seen from Table 20, when the participants

Task	Page Name	Complexity	Number of Participants	Familiarity	Unfamiliarity	Similarity
Browse	Apple	Low	11	FFJI	FCFFE	40 %
	Yahoo	Medium	16	EDED	EEDE	50 %
	BBC	High	15	LKL	KLN	33.3 %
Search	Apple	Low	10	FEFEE	EF	40 %
	Yahoo	Medium	10	E	DEDE	25 %
	BBC	High	16	KMM	KLLM	50 %

Table 19: The common scanpaths on the different Web pages that the participants are familiar and unfamiliar

were familiar with the Web pages, the average length of the common scanpaths for both the searching and browsing tasks was shorter.

Task	Familiarity	Unfamiliarity
Browsing	M: 3.67 SD: 0.58	M: 4 SD: 1
Searching	M: 3 SD: 2	M: 3.33 SD: 1.16
Both	M: 3.33 SD: 1.37	M: 3.67 SD: 1

Table 20: The mean (M) and standard deviation (SD) of the length of common scanpaths for familiarity and unfamiliarity aspects

4.5 Complexity Effects

"How does the Web page complexity impact common scanpaths?"

Table 21 shows the common scanpaths for the six Web pages which have different level of complexity. It is created to investigate the effect of the Web page complexity on common scanpaths.

Task	Page Name	Complexity	Number of Participants	Common Scanpath
Browsing	Apple	Low	36	CF
	Babylon	Low	37	M
	AVG	Medium	38	DD
	Yahoo	Medium	37	EED
	Godaddy	High	38	PPRP
	BBC	High	38	NN
Searching	Apple	Low	31	E
	Babylon	Low	37	MMPQRS
	AVG	Medium	36	DFDF
	Yahoo	Medium	29	E
	Godaddy	High	34	POO
	BBC	High	38	M

Table 21: The common scanpaths on the different Web pages which have different level of complexity

4.6 Segmentation Granularity Effects

"How does the segmentation granularity impact common scanpaths?"

The abstracted individual scanpaths are created by using AoIs generated with the different levels of segmentation. Next, eMINE scanpath algorithm was applied to them to find common scanpaths. These additional segmented Web pages with their segmentation granularity are shown in Figure 28- 39. The results are shown in Table 22. As can be seen in the segmented Web pages provided in this section, the lower level typically produces larger AoIs. For instance, eMINE scanpath algorithm produces DFDF on the Godaddy Web page for the searching task for the 5th level, D(EF)D(EF) for the 4th level and (D...F) for the 3rd level. (EF) means that the AoIs E and F are included by (EF) whereas (D...F) having AoIs D, E, and F of the 5th segmentation level.

Task	Page Name	Complexity	P	Level 3	Level 4	Level 5
Browsing	Apple	Low	36	F(C...E)F	FFFF	CF
	Babylon	Low	37	(J...M)(P...T)	(P...S)	M
	AVG	Medium	38	(D...F)	D(EF)DD	DD
	Yahoo	Medium	37	(DE)	(DE)	EED
	Godaddy	High	38	(N...R)	POOO	PPRP
	BBC	High	37	(K...M,O)N(K...M,O)N	(MN)O(MN)	NN
Searching	Apple	Low	31	(C...E)F	F	E
	Babylon	Low	36	(J...M)(P...T)(J...M)(P...T)(P...T)	M(P...S)	MMPQRS
	AVG	Medium	36	(D...F)	D(EF)D(EF)	DFDF
	Yahoo	Medium	29	(DE)	(DE)	E
	Godaddy	High	34	(N...R)	P(NO)(NO)	POO
	BBC	High	38	(K..M,O)N(K..M,O)	(K..M,O)N(K..M,O)N	M

Table 22: The common scanpaths on the different Web pages which are segmented with different levels

Figure 28: Apple (Level 3)

Figure 29: Babylon (Level 3)

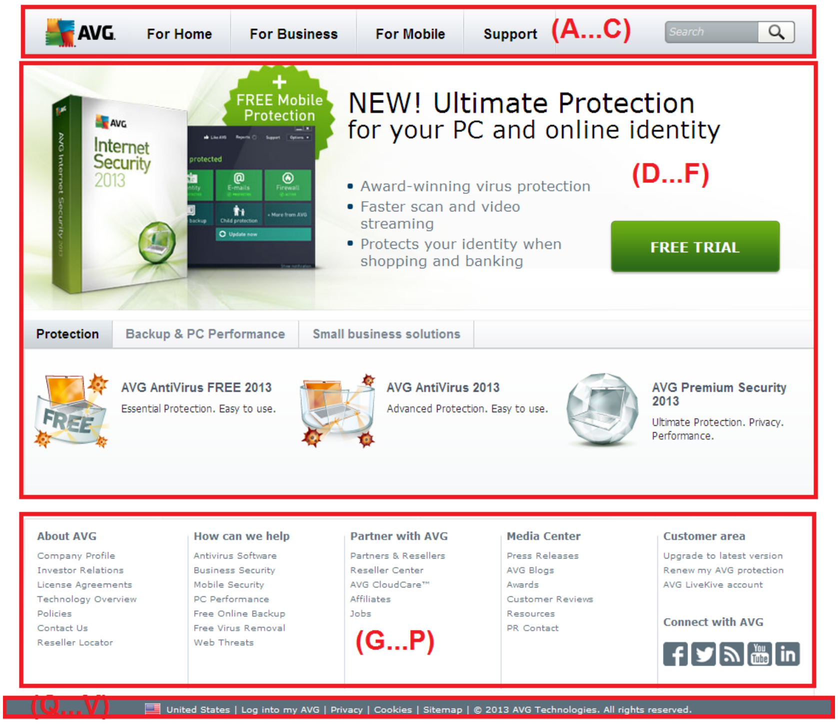

Figure 30: AVG (Level 3)

Figure 31: Yahoo (Level 3)

Figure 32: GoDaddy (Level 3)

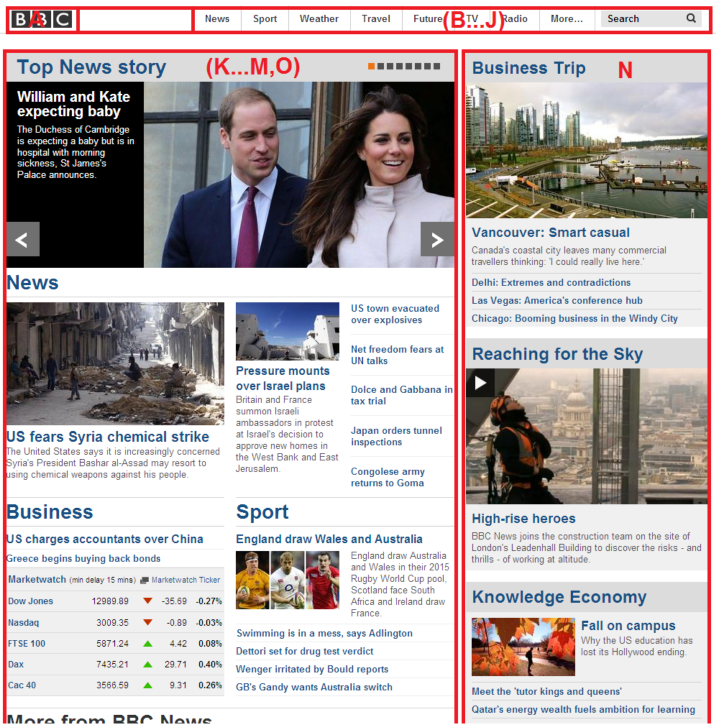

Figure 33: BBC (Level 3)

Figure 34: Apple (Level 4)

Figure 35: Babylon (Level 4)

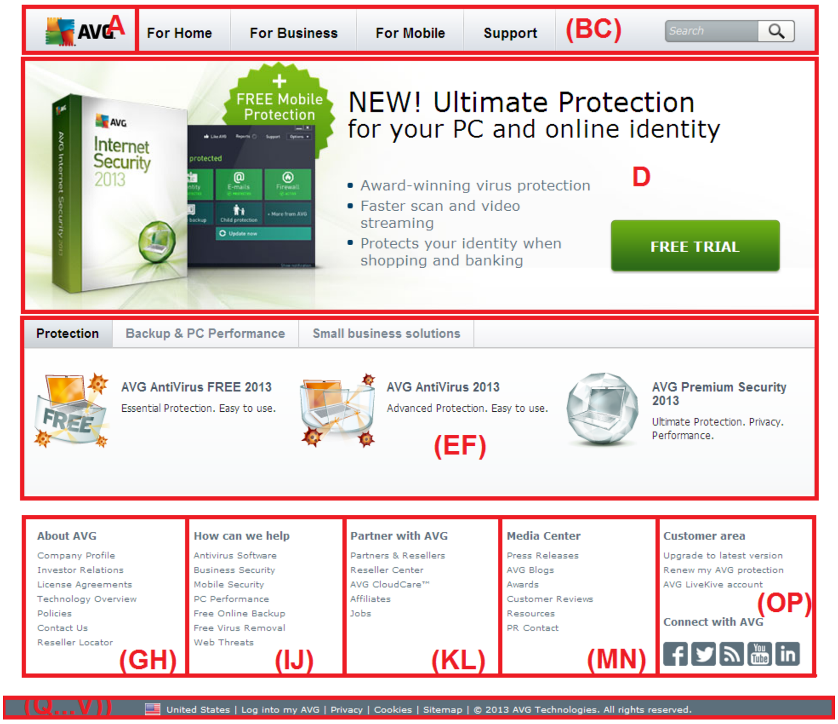

Figure 36: AVG (Level 4)

Figure 37: Yahoo (Level 4)

Figure 38: GoDaddy (Level 4)

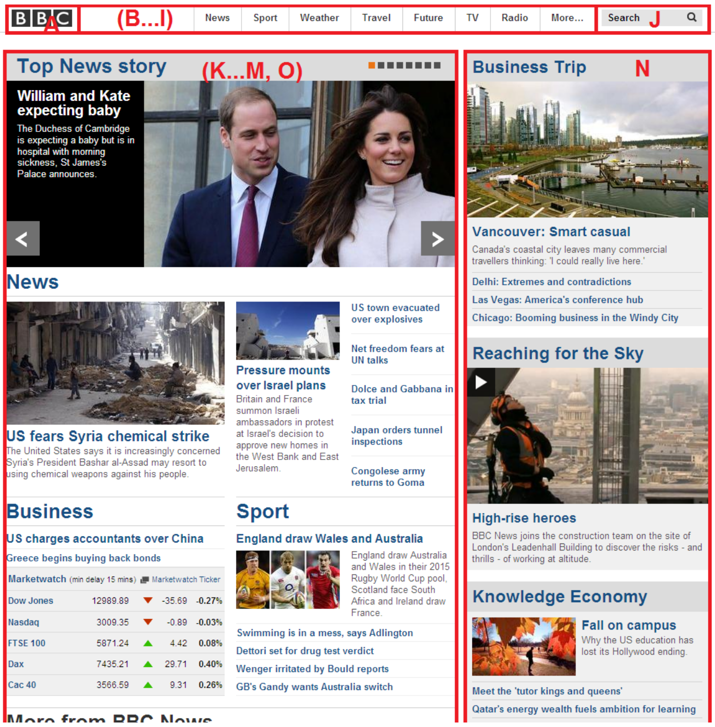

Figure 39: BBC (Level 4)

5 Discussion

We conducted an eye tracking study in order to evaluate eMINE scanpath algorithm. The main purpose is to see whether or not it is able to successfully identify common scanpaths in terms of visual elements of Web pages. Furthermore, the algorithm was evaluated to investigate the effect of the number of individual scanpaths, gender, familiarity, complexity and segmentation granularity.

The participants were required to complete some searching tasks on the Web pages. For example, on the Babylon Web page the participants were asked to locate the link which allows downloading the free version of Babylon and then read the names of other products of Babylon. Therefore, we expected from eMINE scanpath algorithm to produce a common scanpath that support these searching tasks. The results in Section 4.1 show that most of the common scanpaths produced by the algorithm support these tasks whereas some of them partially support the tasks. The common scanpaths for the Apple and Godaddy pages partially support the tasks. For instance, on the Apple Web page the participants were asked to locate a link which allows watching the TV ads relating to iPad mini and then locate a link labeled "iPad" on the main menu. The common scanpath includes the first part but it does include the second part. In order to complete one part of the tasks on the Apple and Godaddy pages, the participants were required to locate small AoIs. Because of the degree of accuracy of the eye tracker, the fixation may not be located in the correct AoI. We should consider the degree of accuracy and the distance between the participants and the eye tracker to address this issue in the future. One solution may be extending the borders of AoIs both vertically and horizontally.

eMINE scanpath algorithm was tested with the different numbers of scanpaths as shown in Table 3. As expected, we can see that the algorithm is slightly more scalable with the searching tasks because the participants were asked to complete some specific tasks. The average similarity is 59.4 % between the common scanpaths which were produced with the different number of scanpaths for the searching tasks whereas the average similarity is 59.1 % for the browsing tasks. There are some differences between scanpaths, such as producing DFDF for 10 participants and DD for 30+ participants on the AVG page because of using the hierarchical structure. eMINE scanpath algorithm uses a hierarchical structure while identifying common scanpaths. It selects the two most similar scanpaths from the list and finds their longest common subsequence. It is iteratively repeated until a single scanpath left. Because of the hierarchical structure, some information in intermediate levels can be lost because of merging two scanpaths. Assume that there are three sequences: S1: GATACCAT S2: CTAAAGTC and S3: GCTATTGCG [8]. S1 and S2 can be aligned firstly and then S1'= - - A - A - - A - - - can obtained [8]. Following this, S1' and S3 can be aligned and then S3'= - - - A - - - - - - - - can be obtained [8]. This example clearly illustrates that the hierarchical structure can make the method reductionist. For example, all of the three scanpaths have G and T in different locations but G and T do not exist at the end. When a number of individual scanpaths is increased, the different most similar scanpath pairs can be generated. This may cause some differences in common scanpaths.

The gender can cause some differences in common scanpaths, too. In particular, the males common scanpath on the Yahoo page is EDE whereas the females common scanpath is E. However, there is no significant difference in the length of common scanpaths overall (Male - M: 3.42 and SD: 1.68; Female M: 3.42 and SD: 1.68). Interestingly, the results show that the average common scanpath length of the males is lower while browsing (Male - M: 2.5 and SD: 0.84; Female - M: 3.67 and SD: 1.37) but is higher while searching (Male - M: 4.33 and SD: 1.86; Female - M: 3.17 and SD: 2) compared to the average common scanpath length of the females. We may consider doing transcoding based on the gender because of these differences. The average similarity between males and females were also calculated. As expected, the average similarity for the browsing tasks is lower (50.8 %) then the average similarity for the searching tasks (66.1 %).

Since there is no sufficient number of participants to investigate the familiarity effects on the Godaddy, Babylon and AVG pages, we had to exclude these pages. However, there is no significant difference in the length of common scanpaths (Familiarity - M: 3.33 and SD: 1.37; Unfamiliarity M: 3.67 and SD: 1). However, the participants mainly looked more different AoIs when they were not familiar with the Web pages. For example, the common scanpath for searching tasks of the people who were familiar with the Yahoo page does not involve D whereas the common scanpath of the people who were not familiar includes D. Similarly, the common scanpath for searching tasks of the people who were familiar with the BBC page does not involve L whereas the common scanpath of the people who were not familiar includes L. Note that the Web pages were shown twice to users: one for browsing and one for searching. Therefore, we need to consider selective perception. Crawley and Graham (2010) indicate that We may attention to only a part of what we are seeing and exclude other information. We choose what to notice, lose other information, and fill in the gaps [9]. Hence, some people may become more familiar with the Web pages when they see it during the eye tracking study. This is another issue which should be considered in the future.

Although 5th segmentation level was identified as the most preferable level by people [3], we wanted to investigate the effect of segmentation granularity, too. As can be seen in the segmented Web pages provided in Section 4.6, the lower level typically produces larger AoIs. Thus, eMINE scanpath algorithm produces the results based on the larger AoIs and these common scanpaths mostly support the common scanpaths produced with the 5th level of segmentation. For instance, eMINE algorithm produces POO for the 5th level, P(NO)(NO) for the 4th level and (NR) for the 3rd level. (NO) means that the AoIs N and O are included by (NO) whereas (N...R) having AoIs N, O, P, Q and R of the 5th segmentation level.

6 Concluding Remarks and Future Work

To sum up, this technical report consists of two main parts: the implementation and evaluation of eMINE scanpath algorithm. eMINE scanpath algorithm was integrated with the extended and improved version of the VIPS algorithm [1]. Web pages firstly segmented with the VIPS algorithm and then eye tracking data is imported to create the abstracted string representation of scanpaths. Following this, eMINE scanpath algorithm is applied to them to produce a common scanpath in terms of visual elements of Web pages. An eye tracking study was conducted to evaluate eMINE scanpath algorithm. The main purpose is to experimentally evaluate validity and scalability of eMINE scanpath algorithm, and to investigate the effect of gender, familiarity, complexity and segmentation granularity. The results clearly show this algorithm is able to identify common scanpaths in terms of visual elements of Web pages, even through it partially supports the searching tasks on the Apple and Godaddy Web pages. The results also show that the gender and familiarity cause some differences in common scanpaths such as having slightly longer common scanpaths or having different AoIs in common scanpaths.

This evaluation shows the importance of pre-processing of eye tracking data once again. Eye tracking datasets consist of a lot of noisy data and these noisy data are likely to decrease the commonality in common patterns in eye tracking data. In addition, people who are not familiar with the Web pages may have unnecessary eye movements as shown in Figure 40 and Figure 41.

Therefore, the datasets should be pre-processed to increase their quality before analysing. For instance, very short fixations, which have no meaning, can be excluded [25, 27]. Pre-processing is also significant to identify the outliers which decrease the commonality in common patterns in eye tracking data.

The groups of users can be identified which similarly traverse on Web pages. For example, females and males may follow a slightly different scanpath to complete some tasks on Web pages. Likewise, people from different age groups may also follow different scanpaths while browsing. Similarly, education background may have effects on scanpaths.

Similar to the existing scanpath analysis methods, eMINE scanpath algorithm tends to ignore the complexities of underlying cognitive processes: when one follows a path to achieve a task, there is a reasoning that affects their decision, and this algorithm do not capture that. All of these issues mentioned above should be taken into consideration for the future improvements.

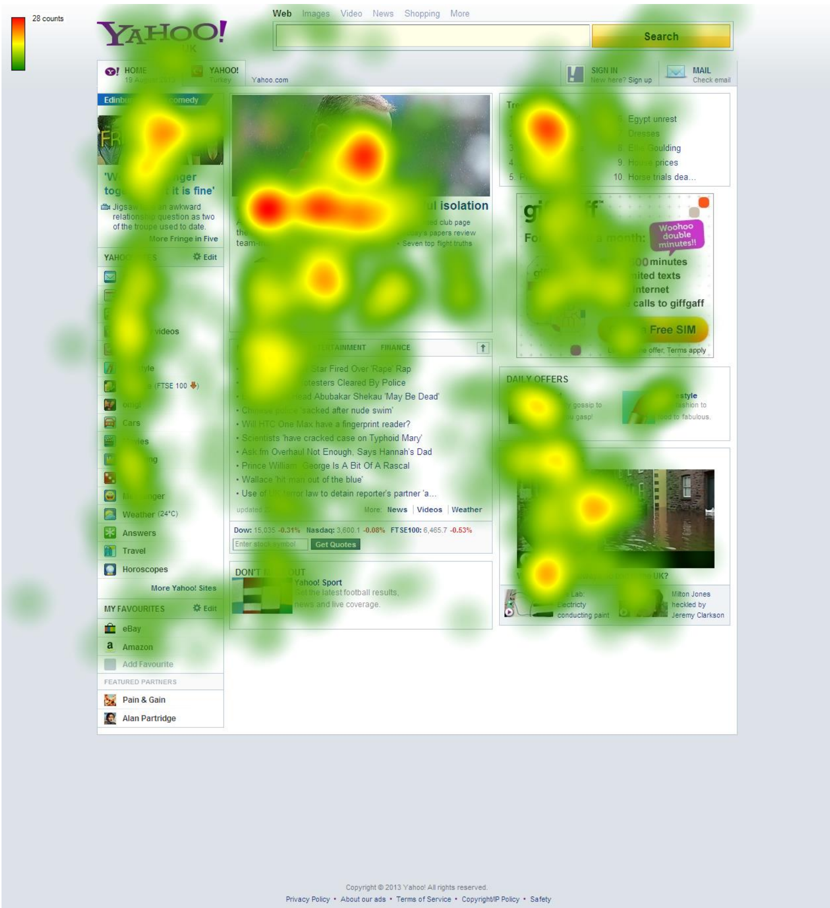

Figure 40: Heat map of the Yahoo page for the people who were familiar

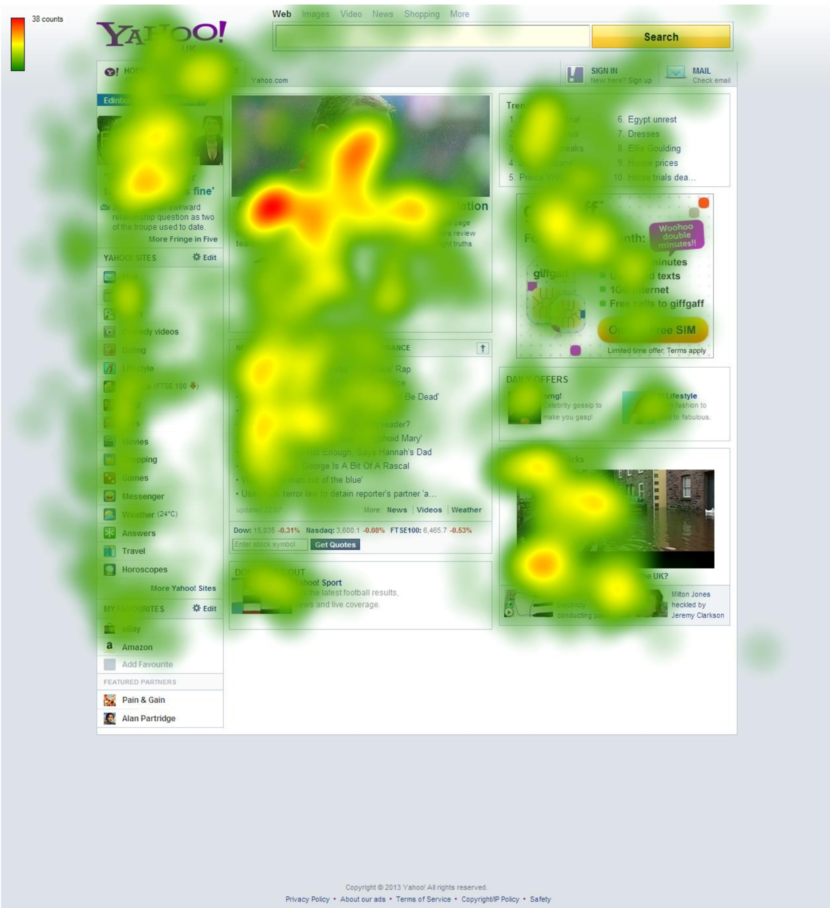

Figure 41: Heat map of the Yahoo page for the people who were not familiar

A Information Sheet

MANCHESTER 1824

The University of Manchester

School of Computer Science

Understanding Eye Tracking Data for Re-engineering Web Pages

Participant Information Sheet

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the research?

Sukru Eraslan

Title of the research.

Understanding Eye Tracking Data for Re-engineering Web Pages

Why have I been chosen?

I am inviting anyone who is computer literate and between the ages of 18 and 60 to take part in the evaluation if they want to.

What would I be asked to do if I take part?

You will be asked to fill a short questionnaire about your demographic information and Web experience. Next, you will be required to complete two simple tasks on three Web pages and just scan other three Web pages while your eye movements are tracked. The pages will be shown to you and the investigator will ask you to complete a task, which can be a particular task or just scanning, on the pages. At the end, your opinions about the Web pages will be asked.

What happens to the data collected?

Electronic data will be stored securely on a computer. Written information will be stored in a locked drawer. The information will be used in preparation of my dissertation.

How is confidentiality maintained?

Data will be made anonymous (names and any other information that may identify an individual will not be included), so no one will be able to recognize who the data belongs to.

Will I be paid for participating in the research?

You will not be paid for participating in the research.

What is the duration of the research?

The study will take less than one hour to complete.

Where will the research be conducted?

Room: SZ-06, Academic S Building

Middle East Technical University

Northern Cyprus Campus Academic

What if I change my mind?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without giving a reason and without detriment to yourself.

Will the outcomes of the research be published?

The outcomes of the research will be published in my thesis and conference proceedings and journal articles.

Contact for further information.

For further information, please contact either myself or my supervisor (details above).

What if something goes wrong?

If a participant wants to make a formal complaint about the conduct of the research they should contact the Head of the Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL

B Questionnaire

MANCHESTER 1824

The University of Manchester

Understanding Eye Tracking Data for Re-engineering Web Pages

Eye Tracking Study - Questionnaire

1. What is your gender?
   - ☐ Female
   - ☐ Male

2. What is your age?
   - ☐ Under18
   - ☐ 18-24
   - ☐ 25-34
   - ☐ 35-54
   - ☐ 55+

3. How often do you use the Web?
   - ☐ Daily
   - ☐ Weekly
   - ☐ Monthly
   - ☐ Less than once a month
   - ☐ Never

4. Highest level of education you have completed:
   - ☐ Grade/Primary School
   - ☐ High/Secondary School
   - ☐ Associates Degree
   - ☐ Bachelors Degree
   - ☐ Masters Degree
   - ☐ Doctorate
   - ☐ Other

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5. Please state how often you visit the following web sites by using the ranking table:

Daily	1
Weekly	2
Monthly	3
Less than once a month	4
Never	5

Table 1: Ranking Table

Web Sites	**How often do you visit the web site?** **(Your answer should be 1,2,3,4 or 5)**
Go Daddy <www.godaddy.com/>	
Apple <http/www.apple.com/>	
AVG <www.avg.com/us-en/index.html>	
Yahoo! <http/www.yahoo.com/>	
babylon <http/www.babylon.com/>	
BBC <http/www.bbc.co.uk/>	

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C Transition Matrix for the Browsing Task on the Babylon Web Page

	R	N	M	H	A	I	K	Q	P	J	S	W	L	F	E	C	U	B	D	G	O
R	000.0%	005.1%	019.7%	000.0%	000.0%	001.3%	001.3%	012.7%	012.7%	001.9%	038.9%	002.5%	001.9%	000.0%	000.0%	000.0%	001.9%	000.0%	000.0%	000.0%	000.0%
N	007.1%	000.0%	024.7%	001.9%	000.0%	003.2%	000.6%	010.4%	039.6%	004.5%	004.5%	002.6%	000.0%	000.0%	000.0%	000.0%	000.6%	000.0%	000.0%	000.0%	000.0%
M	011.0%	011.0%	000.0%	010.1%	000.0%	010.1%	013.1%	010.5%	005.9%	017.7%	003.8%	001.3%	003.8%	001.3%	000.0%	000.0%	000.4%	000.0%	000.0%	000.0%	000.0%
H	004.0%	002.4%	019.4%	000.0%	004.0%	026.6%	007.3%	004.8%	003.2%	012.1%	000.8%	001.6%	001.6%	001.6%	003.2%	001.6%	000.0%	002.4%	002.4%	000.8%	000.0%
A	000.0%	000.0%	027.3%	027.3%	000.0%	000.0%	000.0%	000.0%	009.1%	018.2%	000.0%	000.0%	000.0%	000.0%	000.0%	009.1%	000.0%	000.0%	009.1%	000.0%	000.0%
I	003.5%	002.1%	014.2%	032.6%	000.7%	000.0%	012.1%	002.1%	000.7%	017.7%	000.0%	000.0%	008.5%	000.7%	001.4%	000.0%	000.7%	000.0%	001.4%	001.4%	000.0%
K	002.1%	004.1%	021.6%	013.4%	000.0%	017.5%	000.0%	002.1%	000.0%	024.7%	002.1%	000.0%	010.3%	000.0%	000.0%	001.0%	000.0%	000.0%	001.0%	000.0%	000.0%
Q	039.8%	008.0%	009.7%	002.3%	000.0%	002.3%	001.7%	000.0%	028.4%	002.8%	001.7%	001.1%	000.6%	000.6%	000.0%	000.0%	001.1%	000.0%	000.0%	000.0%	000.0%
P	004.9%	028.4%	008.7%	001.6%	000.0%	002.7%	001.1%	040.4%	000.0%	003.3%	004.4%	002.2%	000.5%	000.0%	000.0%	000.0%	001.6%	000.0%	000.0%	000.0%	000.0%
J	003.9%	011.2%	023.0%	009.2%	000.0%	019.1%	013.2%	002.6%	006.6%	000.0%	000.7%	000.7%	007.2%	000.0%	000.0%	000.0%	000.7%	002.0%	000.0%	000.0%	000.0%
S	017.9%	015.8%	014.7%	001.1%	000.0%	001.1%	001.1%	010.5%	015.8%	005.3%	000.0%	004.2%	007.4%	000.0%	001.1%	000.0%	003.2%	000.0%	000.0%	000.0%	001.1%
W	002.3%	011.4%	013.6%	009.1%	000.0%	000.0%	000.0%	018.2%	011.4%	006.8%	004.5%	000.0%	000.0%	000.0%	000.0%	002.3%	020.5%	000.0%	000.0%	000.0%	000.0%
L	003.6%	003.6%	017.9%	010.7%	000.0%	021.4%	016.1%	003.6%	000.0%	016.1%	001.8%	001.8%	000.0%	000.0%	001.8%	001.8%	000.0%	000.0%	000.0%	000.0%	000.0%
F	000.0%	000.0%	000.0%	020.0%	010.0%	010.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	020.0%	010.0%	000.0%	000.0%	010.0%	020.0%	000.0%
E	000.0%	000.0%	000.0%	007.1%	000.0%	014.3%	000.0%	007.1%	000.0%	014.3%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	014.3%	035.7%	007.1%	000.0%
C	000.0%	000.0%	000.0%	005.0%	000.0%	010.0%	005.0%	000.0%	000.0%	025.0%	000.0%	005.0%	000.0%	000.0%	000.0%	000.0%	005.0%	025.0%	015.0%	005.0%	000.0%
U	004.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	012.0%	016.0%	000.0%	008.0%	060.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%
B	000.0%	000.0%	000.0%	000.0%	020.0%	006.7%	000.0%	000.0%	006.7%	006.7%	000.0%	000.0%	000.0%	000.0%	006.7%	026.7%	000.0%	000.0%	020.0%	006.7%	000.0%
D	000.0%	000.0%	000.0%	000.0%	005.3%	005.3%	000.0%	010.5%	000.0%	005.3%	000.0%	000.0%	000.0%	000.0%	010.5%	052.6%	000.0%	010.5%	000.0%	000.0%	000.0%
G	000.0%	000.0%	012.5%	012.5%	000.0%	000.0%	012.5%	000.0%	000.0%	000.0%	012.5%	000.0%	000.0%	037.5%	012.5%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%
O	000.0%	100.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%

D Transition Matrix for the Browsing Task on the AVG Web Page

	F	D	E	B	J	N	P	L	I	A	S	R	O	H	C	K	G	M
F	000.0%	061.4%	023.2%	002.1%	001.7%	000.9%	002.1%	002.1%	000.9%	000.4%	000.4%	000.0%	000.9%	001.7%	000.0%	000.4%	001.7%	000.0%
D	057.3%	000.0%	014.6%	016.7%	001.2%	000.4%	002.4%	001.2%	000.0%	002.0%	000.0%	000.0%	001.2%	000.0%	001.6%	000.4%	000.0%	000.8%
E	059.2%	035.9%	000.0%	001.9%	001.0%	000.0%	001.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	001.0%	000.0%
B	013.7%	060.8%	005.9%	000.0%	000.0%	000.0%	003.9%	000.0%	000.0%	011.8%	000.0%	000.0%	000.0%	000.0%	003.9%	000.0%	000.0%	000.0%
J	038.9%	011.1%	005.6%	000.0%	000.0%	011.1%	000.0%	016.7%	000.0%	000.0%	000.0%	000.0%	000.0%	016.7%	000.0%	000.0%	000.0%	000.0%
N	042.9%	000.0%	014.3%	000.0%	007.1%	000.0%	007.1%	000.0%	000.0%	000.0%	000.0%	000.0%	028.6%	000.0%	000.0%	000.0%	000.0%	000.0%
P	042.1%	026.3%	005.3%	000.0%	005.3%	010.5%	000.0%	000.0%	000.0%	000.0%	000.0%	005.3%	005.3%	000.0%	000.0%	000.0%	000.0%	000.0%
L	028.6%	014.3%	000.0%	000.0%	014.3%	035.7%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	007.1%	000.0%	000.0%	000.0%	000.0%	000.0%
I	040.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	020.0%	000.0%	020.0%	020.0%	000.0%
A	000.0%	083.3%	008.3%	008.3%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%
S	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	100.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%
R	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	100.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%
O	030.8%	015.4%	000.0%	007.7%	000.0%	007.7%	015.4%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	007.7%	000.0%	015.4%	000.0%	000.0%
H	050.0%	000.0%	000.0%	000.0%	025.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	012.5%	000.0%	000.0%	000.0%	012.5%	000.0%
C	016.7%	050.0%	000.0%	016.7%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	016.7%	000.0%	000.0%	000.0%	000.0%	000.0%
K	050.0%	000.0%	000.0%	000.0%	000.0%	000.0%	016.7%	000.0%	016.7%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	016.7%
G	016.7%	016.7%	000.0%	000.0%	016.7%	016.7%	000.0%	000.0%	033.3%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%
M	033.3%	000.0%	000.0%	000.0%	000.0%	000.0%	033.3%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	000.0%	033.3%	000.0%	000.0%

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