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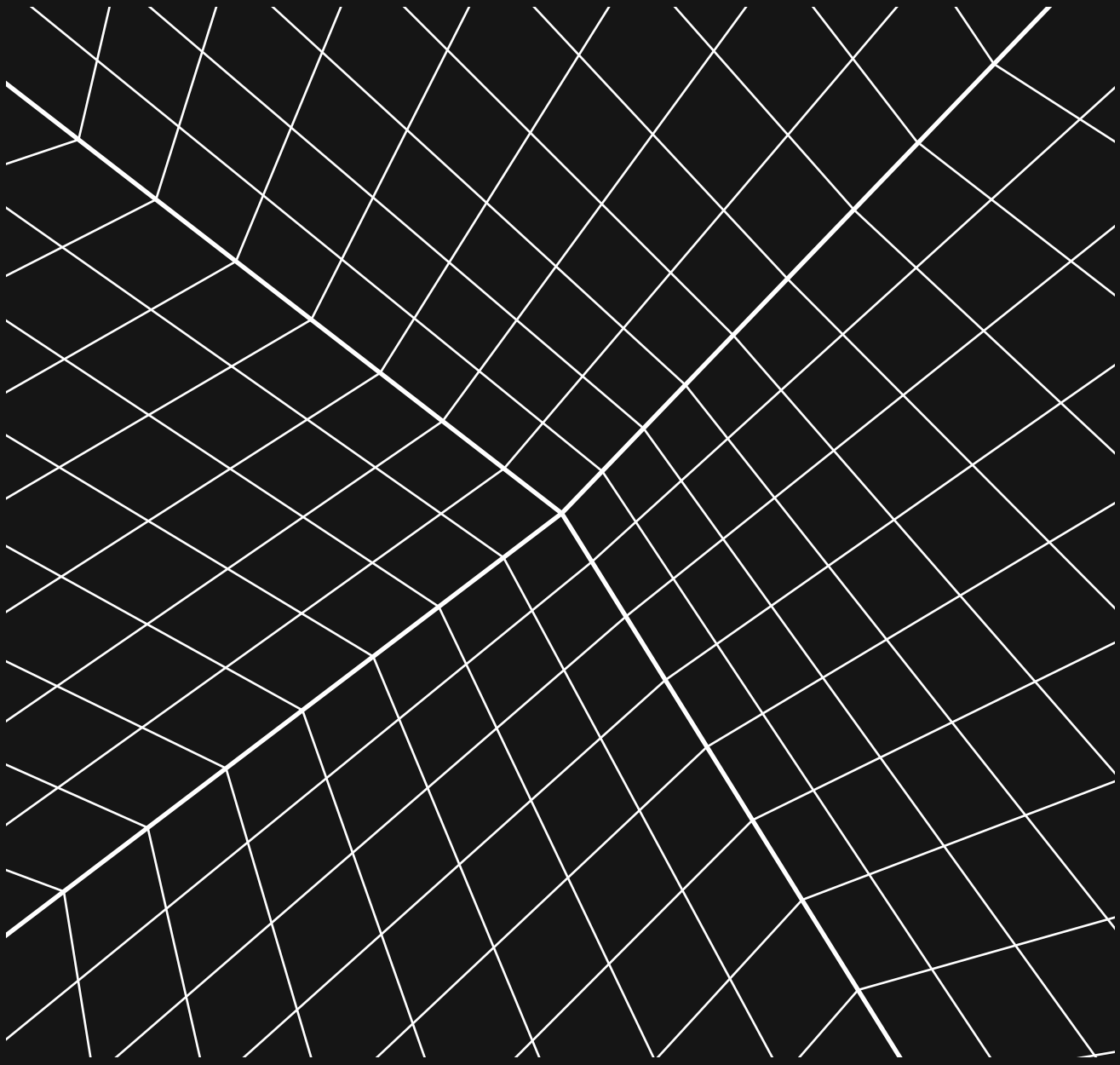

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Visualization Works-in-Progress

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LiveThumbs: A Visual Aid for Web Page Revisitation

Luis A. Leiva
ITI/DSIC – Universitat Politècnica de València
Camí de Vera, s/n - 46022 (Spain)
llt@acm.org

V. Javier Traver[1,2]
Vicente Castelló[1]
[1]iNIT – Institute of New Imaging Technologies
[2]Computer Languages & Systems Dep.
Jaume-I University, Castellón (Spain)
{vtraver,castellv}@uji.es

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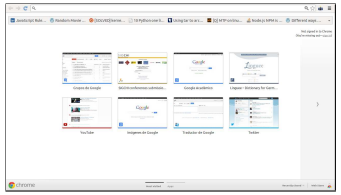
Abstract
One problem web users often face is that of remembering which previously visited page is likely to contain some particular piece of information they are now interested in. To ease this revisitation task, we propose a novel approach: using "live" thumbnails, or small video-like animations of a web page. Our approach is grounded on a two-fold notion: (1) live thumbnails should be more informative than their static counterparts, and (2) live thumbnails can help the user disambiguate among perceptually similar pages. We evaluate a proof-of-concept prototype with 13 users. Preliminary results show that our approach has an interesting potential to enhance web page revisitation in a visually compelling way.

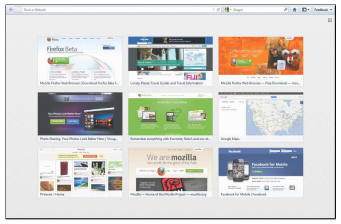
Author Keywords
Revisitation; Thumbnails; Web page summarization

ACM Classification Keywords
H.5.1 [**Information interfaces and presentation**]: Multimedia Information Systems—*Animations*

Introduction
Revisitation, or re-finding pages that were visited in the past, is an everyday activity web users do, often more frequently than searching for new information [2]. To facilitate page revisitation, web browsers provide many

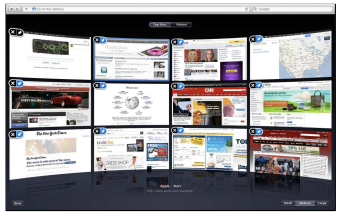


(a) Google Chrome



(b) Mozilla Firefox

(c) Opera



(d) Safari

Figure 1: Speed dials featured in some of the major web browsers.

different methods such as URL autocompletion, bookmarks, a browsing history list, and, more recently, the "speed dial", a dedicated page with slots containing a number of bookmarks of recently visited pages.

Today, the speed dial is featured by major web browsers as a grid of thumbnails (Figure 1), which is shown to the user whenever a new tab is opened. While there exist a myriad of browser extensions that allow to manipulate, edit, or rearrange the slots of the speed dial, little research has been done to improve the thumbnails to ease revisitation. For instance, a problem we have observed is that thumbnails of similar web pages can be shown at a time in the speed dial, and therefore it might be difficult for users to quickly disambiguate among them. Similarly, thumbnails may not be enough to provide the user with all the relevant information about a previously visited page. Toward addressing these shortcomings, we believe visual summarization of web pages need to be revisited.

Related Work and Contribution

Different summarizations of web pages may be more adequate for different browsing tasks, search questions, or types of web pages [5, 10]. Overall, the best revisitation performance is usually obtained by using a combination of thumbnail + text (snippet, page title, etc.) [1, 3]. Advanced techniques use computational models of visual salience so that the (potentially) most informative parts of images are automatically cropped for thumbnail generation [8]. Other authors use machine learning algorithms to detect the dominant image within a web page [5]. In this line, Teevan et al. [9] composed a salient image and some salient text from the page together with a watermarked image. However, most of these approaches make the assumption that the web page contains images, which therefore render these systems non-generalizable.

Moreover, given their simplicity, regular thumbnails are easier to generate and, as a result, they may eventually scale better than advanced summarization techniques.

In this paper, we propose LiveThumbs (live thumbnails), a novel representation technique to summarize web pages by generating video-like thumbnail animations of the browsed websites. The purpose of this work is to explore whether our approach provides discriminative information that can be effective for revisitation tasks. Arguably, live thumbnails of web pages can be particularly effective in scenarios where (1) the user wants to evaluate quickly the relevance of a previously visited web and/or (2) some of the visited pages are visually similar and therefore regular thumbnails can be hardly informative.

LiveThumbs Design

The design of a speed dial containing LiveThumbs entails two different challenges, namely *how* should animations be performed and *when* animations should take part, since what works for an individual LiveThumb may not work for the full speed dial. We discuss several design choices for each of these two problems below.

How to animate

Some possibilities to generate a LiveThumb of a web page include the following:

1. Snapshot-based: Spatially divide the page into a number of snapshots, assign one snapshot per frame, and build the video with a proper frame rate.
2. Scroll-based: Perform a scrolling animation of the page from its header to its footer. The frame rate or video length should be chosen as a function of the page size and possibly other design considerations.
3. Zoom-based: Rather than scrolling the page, some parts could be zoomed in and out, so that interesting

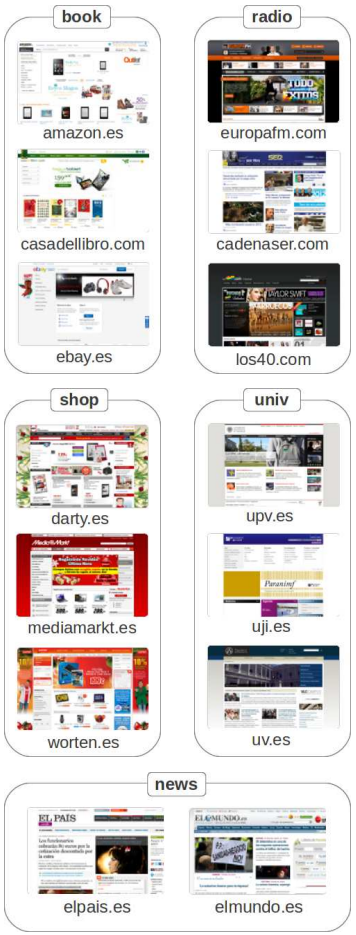


Figure 2: Fourteen pages categorized into 5 groups were used in the evaluation.

parts can be seen at a greater detail/resolution.

4. Salience-based: Build individual frames from (visually) salient parts within the page. Salience could be automatically determined with existing computer models of bottom-up salience.
5. Navigation-based: Use only parts of the web pages that the user has interacted with for some time. The rationale is that non-browsed parts of the web page are unlikely to be easily recognizable and, hence, perhaps are not useful. User actions and navigation choices can be exploited in a similar vein as in [6].

Some approaches (e.g., item 4) may be computationally demanding if performed "on the fly". Others (e.g., item 5) require user's consent due to privacy issues.

When to animate

When several live thumbnails are displayed at once, there are different strategies of when animation should take place. Just to name a few:

1. Play on request (PoR): Play a live thumbnail only when the user explicitly requests it, namely by hovering the thumbnail with the mouse.
2. Stop on request (SoR): All thumbnails are playing at once and the user would explicitly request a particular live thumbnail to stop.
3. Play competing: Only thumbnails corresponding to top visited pages would play at a time, as if they were striving to attract the user's attention.
4. Ambiguity-based: The degree of visual ambiguity among the web pages could be automatically computed and only the thumbnails of mutually similar pages would play automatically.
5. Gaze-based: Play the thumbnail the user is looking at. Though very appealing, this choice requires an eye tracker and dedicated software.

Among these possibilities, the smart animation (item 4) is challenging because of the semantic gap between human perception and current computer-vision technology.

Evaluation

We were interested in getting initial feedback from users about the potential benefit and limitations of LiveThumbs in comparison to using regular (static) thumbnails. Thus, we decided to evaluate snapshot-based and scroll-based animations using either PoR or SoR, since these choices have complementary features. On the one hand, snapshot-based animations require a shorter amount of time to reveal all page parts; but at the same time it can be difficult to get an overall picture of the page, since there is no visual continuity. Vice versa for scroll-based animations. On the other hand, PoR may require more user interaction and perhaps is more physically demanding, whereas SoR can be perceived as cognitively stressful.

Prototype: As shown in Figure 2, 14 popular Spanish websites were selected according to some common topic (e.g., news websites). An HTML5 web-based prototype was developed, containing a speed dial of 2 rows $\times$ 4 columns with thumbnails of 190×120 px each that were randomly chosen among the 14 selected websites. Since we were interested in assessing the usefulness of the thumbnails as a *visual* aid, text captions were not shown.

Participants: Thirteen regular web users (4 females) aged 20–50 with backgrounds in humanities, science, or engineering volunteered in the study.

Procedure: In a first session, participants filled in a survey about revisitation habits (*survey* stage). Then, participants were shown thumbnails examples of all conditions we considered evaluating: static thumbnails and {scroll, snapshot} $\times$ {SoR, PoR} LiveThumbs.

S_1: Where can you find the cheapest 32 GB iPod Touch? [URLs shown: 'shop' group]

S_2: Where can you find books showing a clear percent discount symbol on their cover? [URLs shown: 'book' group]

Figure 3: Situations given to the participants at the search stage.

R_1: You wish to buy an iPod Touch at the website you found it the cheapest. [Relevant webs shown in the speed dial: 'shop' group]

R_2: You wish to buy a book that had a percent discount symbol on its cover. You remember that the home page of the website had images similar to this one. [Relevant webs shown in the speed dial: 'book' group]

R_3: The website of a university contains a daily event agenda in the home page. You wish to consult which events are scheduled for today. [Relevant webs shown in the speed dial: 'univ' group]

Figure 4: Situations given to the participants at the recall stage.

Subjective ratings and other questions about opinions and preferences were elicited via 1–5 Likert scores, which all but one user completed. Participants were also required to perform two search tasks (*search* stage, Figure 3). This session was completed in about 25 minutes.

In a follow-up session (*recall* stage), participants were presented with three different situations (Figure 4) and were asked to click on the thumbnail they thought would be the best choice to answer the question given. Two of those situations (R_1 and R_2) were related to the search tasks performed in the first session and were actual recall tasks. For R_2, an image was provided as a visual prompt, since we found some users failed to find this particular piece of information during the search stage. The third task (R_3) was meant to observe the effect of the thumbnails for identifying a non-browsed page.

For each task, the displayed speed dial contained the thumbnails that were relevant to the task (as indicated in Figure 4) plus a series of randomly chosen thumbnails, up to completing the 8 slots of the speed dial. All thumbnails were randomly placed in the speed dial. Participants spent about 10 minutes to finish this session.

Participants were split into 5 short-term and 8 long-term revisitors, according to how long after the search stage (first session) they performed the recall stage, either a few minutes or a week later, respectively. For the recall stage, the static and live thumbnails were randomly assigned to each participant. Long-term revisitors that were assigned the experimental condition (LiveThumbs) were provided with their preferred animation choices, whereas short-term LiveThumbs users were given a random choice. Eventually, seven users were assigned some form of LiveThumbs, two of them with SoR. Mouse events were tracked in the background while performing each task.

Results

From the results of the survey, together with participants' think-aloud comments during the evaluation, and our own observations, the following findings emerged.

Revisitation Habits

Participants stated that, overall, they do not use bookmarks (M=2.8, SD=1.3) or thumbnails (M=2.2, SD=1.4) for revisitation. Instead, they typically search the pages again (M=3.4, SD=1.0) or use the browser's built-in URL autocompletion (M=3.7, SD=1.2). When users revisit, although they usually know how to access those web pages (M=4.0, SD=0.9), they often have problems to find some particular piece of information (M=3.0, SD=1.4). As a result, participants pointed out that this usually causes frustration (M=3.8, SD=1.0).

LiveThumbs Preferences

LiveThumbs were judged to be helpful in distinguishing visually similar pages (M=4.6, SD=0.5) as well as to decide quicker which pages are worth revisiting (M=4.1, SD=0.8). Nevertheless, many users found the scroll-based animation "too slow", and SoR rather "dizzy". In addition, snapshot-based animation was found to be sometimes confusing because, due to the lack of visual continuity, *"one may loose track of which part of the web page each snapshot refers to"* or *"each snapshot can be thought to refer to different web pages"*. Most of the users ended up preferring scroll over snapshot animations (8 out of 12), and PoR over SoR (10 out of 12). All in all, the emotional experience regarding LiveThumbs was rather positive (M=4.4, SD=0.7) and the interest in further development was evident (M=4.3, SD=0.8). One participant who found regular speed dials very useful made the informal yet encouraging comment that she wished she could use LiveThumbs on a daily basis.

Task	Thumbnail type	
	Static	LiveThumb
R_1	83.3%	42.8%
R_2	16.6%	83.3%
R_3	16.6%	71.4%

Table 1: Revisitation results (recall stage of the evaluation).

Revisitation Results and Discussion
Task R_1 did not clearly reveal a particularly strong benefit toward using LiveThumbs, mainly because most participants did not find the requested information at the search stage. Perhaps the thumbnails (either static or animated) could have included some navigation-based cues to better assist participants in answering the question given. However, for tasks R_2 and R_3, LiveThumbs was found to be superior than regular thumbnails. Concretely, to solve R_3, the lower part of the three task-relevant thumbnails had to be inspected. Interestingly, some of the LiveThumbs users hovered the cursor over the relevant thumbnails and correctly clicked on the right one. One participant using static thumbnails did miss not having LiveThumbs to properly solve this task. To illustrate some of these behaviors, Figure 5 shows two sample mouse tracks. No difference between short-term and long-term revisitors was noticed.

Since the upper part of web thumbnails tends to be rather informative (mainly because of a site logo or a navigation menu), it turns out that LiveThumbs users may perform slower than users of static thumbnails because, depending on the task, they may have to wait for this part of the thumbnail to become visible. This is particularly true for scroll-based animation or if the user accidentally started the animation if using PoR, something we observed during the evaluation. This suggests that a better design of LiveThumbs should include the best of both worlds (static and animation, see next section) and that users might prefer having better control over the animation options.

Future work

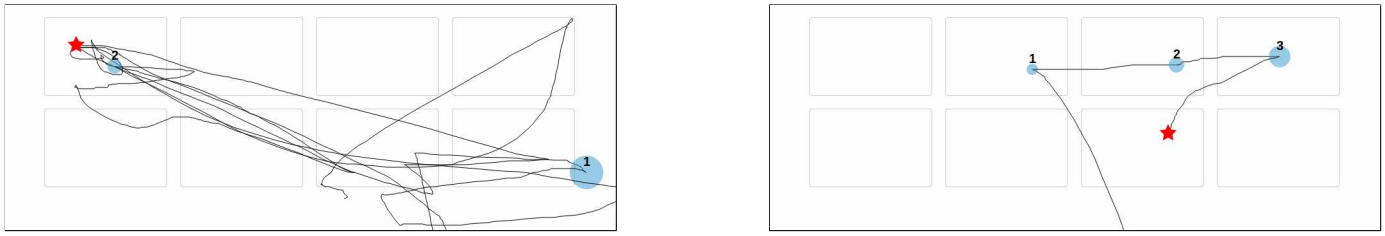
Leveraging Visual Attention
Visual change and motion are powerful cues attracting attention to peripheral areas [7]. This has a clear connection with LiveThumbs, and explains why a speed dial of thumbnails that are animated all at once is found to be distracting. Although the effect of animation on attention is generally not completely understood, as it depends on the type of animation, user, and task [4], it is a key factor to be considered for future work.

Further Evaluation
We will consider the effect of using less popular/familiar web pages, different grid sizes for the speed dial, and more realistic and user-driven search/recall tasks, possibly with a longitudinal field study. Other avenues for future work include researching what kinds of LiveThumb techniques are best for different types of websites.

Redesigning LiveThumbs
Since the animations we evaluated may hinder the primary task of web page revisitation either with too slow or non-continuous animation, a couple of redesign tasks are devised. On the one hand, we are investigating approaches to preserve some information from the upper part of the web pages while animating. For instance, we are considering to overlay the website logo (if any) or the favicon on top of the animation. On the other hand, we will deploy LiveThumbs as a browser extension, in order to provide the user with customization options and more interaction possibilities. For instance, in a production-ready environment, users should be able to decide the behavior of LiveThumbs (e.g., set PoR, SoR, animation duration, etc.) that best suits their needs.

Conclusions

Although limited variations of thumbnail animations were explored, valuable feedback and insights have been gained. One important finding is that users are likely to interact with thumbnail animations on demand. Live thumbnails



(a) Regular thumbnail user (task R_3)

(b) Scroll-based SoR LiveThumbs user (task R_1)

Figure 5: Mouse tracks from two recall tasks. Blue circles denote dwell times, while a red star represents a mouse click. Since the original speed dial was not recorded, a diagrammatic one is shown instead. [5a] User hesitates because he finds static thumbnails to be uninformative for the task; yet finally he makes a random (wrong) choice. [5b] User pauses three thumbnails to better inspect their contents, which eventually leads him to make a (right) choice.

provide the user with a novel page revisitation facility at two levels of detail. Like regular thumbnails, an overall view of multiple pages is offered for quickly spoting a page of interest. However, LiveThumbs enables the possibility of revealing additional details of the web pages, which may help the user to disambiguate among perceptually similar pages. As a result, LiveThumbs features the interesting possibility of easily "navigating" a handful of web pages without having to explicitly browse them.

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