

Scholarly Review: Web Technologies for Responsive Web Design

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Abstract

Nowadays, the spread of new display devices with new screen sizes has drastically changed web-based technologies. Each of these devices have variations in size, functionality, orientation, screen resolution, color, etc. These situations challenge the web design landscape. Therefore, web designers have to deal with demands of new web technologies such as responsive and interactive web designs in order to handle various kinds of device-related variations that will be able to respond to user's behaviors and environments based on screen sizes, platforms and orientations. In this paper, we study and review state-of-the-art web technologies regarding responsive front-end web design. We additionally dig some popular tools that has emerged to confront the current challenges of latest responsive web technologies. We afterwards present a statistical comparison to current popular responsive framework such as bootstrap, foundation and semanticUI, that have been widely used in various applications: business areas, software development process, web-based visualization areas and other web-based areas.

Keywords: Review, Web Technology, Web Design, Front-End, Responsive Framework

1. Introduction

Today's internet web sites are decorated with attractive designs that is more visualized, adaptive, responsive and interactive designs that are capable to respond to the properties of the media that is used to render them [1]. As a number of mobile devices users are increasingly emerging as daily rate, responsive web design has become an important method to improve the mobile device users' experiences and accessibility in browsing the web [1, 2, 3].

As web designs are individually created for each different address, their designs should be unique with different content, audience and goals. Early web pages were simple HTML files with less attractive and adaptive designs to be flexible with mobile-wise web developments. The most common web landscapes with desktop browser, are based on typographic grids, which was introduced and became popular in the mid of 1900 [2, 3]. Although typographic grids were originally intended for printed media, today's web technologies came to use it as the foundation of web designs. However, flexibility and inflexibility of typographic grids led to problems due to their fixed-width to corresponding devices [2].

The practice use of web pages consists of a mix of flexible grids and layouts, images and visual aids, and smart usage of styles, and a kind of media queries. Since the user may switch the web pages (e.g facebook, youtube, yahoo, ted talks, etc) from their personal computers to portable devices such as tablet, cell phone, smart watch, etc which are designated in different sizes and architectures[4]. The rising popularity of smart devices makes the web technology to be flexible with different orientation (landscape, portrait) and to be compatible with different kinds of browsers such as IE, Safari, Chrome, etc for both desktop and phone versions as well as mini UC browser which is developed by Alibaba group [8]. Therefore, it has been aggressively demanding responsive web design to be fit in the screen they are in and also to be responsive to user experiences and behaviors in a fast and efficient ways without loading to server whenever a user needs to see some updated information on her/his web pages.

This paper is motivated not only by current demands for exploration of web technologies and also to keep pace the trends of cutting-edge

technologies in the aspect of web-based development courses.

In this paper, we firstly discuss about what a responsive web design is and current web technology trends. We then present the paper by categorizing its major elements (screen resolution, layout, and media queries) of web designs, popular and latest web design tools in current web market, and their benefits and potential challenges in the future.

The rest of the paper is organized as follows. The contemporary scholarly works related with responsive web technologies are examined in Section 2. The preliminary studies of underlying theory of responsive web pages are discussed in Section 3. The detailed explanation of advantages and challenges of today's web pages are also studied in that section before explaining the statistical data about responsive web frameworks that are analyzed in Section 4. The paper is finally concluded in Section 5.

2. Related Work

We could not find many direct attempts in literature views regarding responsive web design we are now presenting in this paper but rather we found a very few research papers that tangentially address these issues.

Farrukh et al [1] review some of the state-of-the-art web technologies and frameworks for quick interactive web development for both browser-based and mobile-based web applications.

Aparna et al [4] proposes a novel approach to create HTML page automatically from the GUI design drawn on the paper. It considers a GUI design having various HTML controls such as radio buttons, checkbox, textbox, command button and label. A scanned image of GUI design is provided as an input to the system. The system then segments the various HTML controls that will be afterwards identified and stored in XML database. Then, XML file is parsed to generic HTML page.

Shaikh et. al. [3] presented some state-of-the-art web-based tools and libraries for client-side

browser-based visualization. They introduced a novel web-based network visualizer and simulator application which utilizes HTML, JavaScript and Bootstrap.

3. Responsive Web Design

In today's device-oriented world, there is one popular motto so-called "one-design-fits-all" as shown in Figure 1 directly referenced from [8].

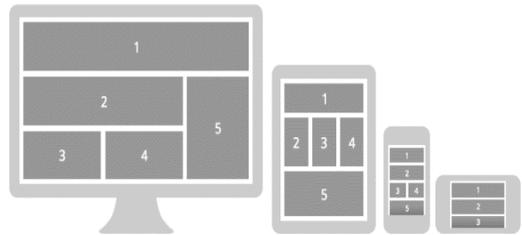


Figure 1. responsive web design in all devices

Not only sizeable content in all devices, it also supports adaptable layout designs: landscape and portrait in various horizontal and vertical sizes. Although responsive web design provides abovementioned features, it still has some difficulties to develop customized sites or applications. Moreover, there are certainly technical challenges that we would like to highlight in this paper regarding implementing responsive designs in all devices. They are screen resolution, custom layout structure, media queries [1, 3, 5].

a) screen resolution

The rising popularity of screen display makes challenges in displaying on different sizes composed of variations in size, functionality and even color. In implementing responsive designs, when the page is loaded, all files are rewritten to their original forms, and only the large or small images are loaded as necessary. Depending on devices sizes, lower or higher resolution images, small or large resolutions of video (such as HD, 1080p, 720p, 360p, etc) are loaded as necessary using meta tag inside of header portion of html5 as shown in Figure 2.

```
<meta name="viewport"
content="width=device-width; initial-
scale=1.0">
```

Figure 2. Meta tag for different scales of devices

b) layout structure

A responsive layout enables the delivery of relevant content on specific devices. For example, a large sliding banner on a web site's homepage to link various areas of other sites is not a fit for a mobile device. But since a site is responsive, smartphone users would see small thumbnails of these banners, thereby making it easier for users to navigate.

Fluid and grid layouts are widespread and popular design practice for division of vertical and horizontal web structure content. They help system scalability and improves the readability of the content on the website or within a mobile application. But, it still needs to continue with additional features and widgets to be more responsive for all devices.

c) media queries

The current design technology CSS3 supports all of the same media types available in previous versions with additional new media features such as max-width, device-width, orientation and color; that will be flexible in all type of portable devices (mobile phones, tablets, etc) and fixed devices (4K TV, desktop computers, etc).

```
<link rel="stylesheet"
type="text/css"
media="screen and (max-device-
width: 480px)"
href="thae.css" />
```

Figure 3: an example media query

This media query is fairly self-explanatory: if the browser displays this page on a screen (rather than print, etc), and if the width of the screen (not

necessarily the viewport) is 480 pixels or less, then load thae.css as shown in Figure 3.

3.1. Benefits and Challenges of Responsive Web Design

As the popularity of responsive web design is increasing, the benefits of it is also rising as follows.

- It supports a wider range of screen sizes and devices with a single website in different screen resolutions like 320, 768 and 960 pixels wide.
- It is user friendly and provides adaptable design layout and attractive font, color and animation design.

On the contrary, although responsive web pages have reached a significant satisfactory level for all almost devices, there are still challenges as follows.

- Websites loading and downloading some files are slower than computers.
- Even with the spread of responsive design, it has some display problems for wearable devices that has 272px by 340px in size which can only display two lines of text [8].
- Redesigning of the existing site will be subtle due to different layouts and styles for each device. It can cost extra expenditures in maintaining and redesigning the sites.

As technology industry expects, the challenges will continue for wearable designs with different capabilities and limitations, that is, designs will not probably depend on screen agnostic, but screen independent [1, 3, ,8].

3.2. Latest Front-End Web Library

The three important ingredients in building responsive websites for all sizes of devices are JavaScript, html5 and css3. Unlike traditional web programming for front-end design in many years ago, there are light-weight frameworks even for front-end UI/UX designs such as AngularJS for JavaScript framework, bootstrap4 for CSS library, etc.

These frameworks and libraries give a way to handle navigation between different views, and

typically split the application into layers with MVC (model-view-controller) design patterns; and additionally increase the web page load accessibility without routing to the server for every update on the web. Instead, they perform client-side requests to the browser and show the updates to the user back in the browser without need of round-trips travelling to the server. The followings are some of popular libraries for front-end designs.

AngularJS: AngularJS is a JavaScript-based open-source front-end web application framework mainly maintained by Google. AngularJS is a structural framework for dynamic web apps to address many of the challenges encountered in developing single-page responsive applications [5].

HTML5: HTML5 is the latest version of Hypertext Markup Language. It is designed to deliver attractive designs with less code. It includes detailed processing models to encourage more interoperable implementations and introduces markup and application programming interfaces (APIs) for complex web applications [7].

Google’s Material Design Library: This is a new library of UI components called material design, which is alternative form of bootstrap. It is designated for cross-device use and comes with a set of beautiful UI components. Material design is a unified system with theory, resources and tools for developing responsive and interactive web designs [1, 8].

3.3. Comparison of Popular Responsive Front-End Frameworks

A front-end framework is referred to as CSS, HTML and JS files that provide front-end developers a platform to base their work on. Using a framework for projects allows web developers to use a common set of code to initiate a project rather than having to write it from scratch for each web development project that they take on. In this section, we compare three popular responsive frameworks namely Bootstrap, Foundation and Semantic UI as follows.

a) Bootstrap: Bootstrap is the most popular and open source toolkit for HTML, CSS and JS framework in the world of building responsive, mobile-first projects on the web [6]. It can provide responsive grid system, extensive prebuilt components and powerful plugins in built on jQuery.

Table 1. Comparison of features and characteristics of popular responsive front-end frameworks

| | Bootstrap | Foundation | SemanticUI |
|-----------------------------------|-----------|------------|------------|
| Open Source Software | Yes | No | Yes |
| Supported Themes (+20) | No | Yes | Yes |
| Additional features and widgets | Yes | Yes | Yes |
| Structure Complexity | No | Yes | Yes |
| Code Bloat | Yes | Yes | Yes |
| Advanced web design Skills needed | No | Yes | No |
| Highest Usage Level | Yes | No | Yes |
| Completeness to market place | Yes | Yes | No |

b) Foundation: Foundation is a highly modular framework that is intended to any device, medium and accessibility. The framework provides plenty of features with creating websites, applications and email templates. It was launched in 2011 under MIT license and has made constant upgrades with addition of resources, code snippets and HTML templates [9].

c) Semantic UI: Semantic UI was initially developed by Jack Lukic with the aim of creating common language [10]. The framework is in early days but has capability of becoming one of the most widely used front-end development tool.

The comparison of features and tools they can provide and characteristics they have and their

levels to the user is listed in Table 1 by organizing corresponding categories for each.

3. Conclusion

Before mobile devices began soaring to popularity, the main challenge web designers had to deal with was keeping the same look and feel of their websites. But the spread of mobile devices has drastically changed the web design landscape. A multitude of different screen sizes exist across phones, "phablets," tablets, desktops, game consoles, TVs, and even wearables. Screen sizes are always changing, so it is important that web site can adapt to any screen size, today or in the future. This paper discusses the current trends of web design technology with their popular tools and also presents the current and future challenges in web design technology.

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