Responsive Design and Development: Methods, Technologies and Current Issues

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Abstract. Responsive design is a major trend in web development to cater for the diversity of devices used for web browsing. However, applying responsive design to existing web sites often involves major reengineering due to the underlying fluid grid concept. Moreover, applications of responsive design are currently limited to desktop-to-mobile adaptation. This tutorial introduces the main ideas behind responsive design with a focus on the methods and technologies. Based on previous research, we highlight several limitations of the original approach and show how the concepts and methods can be extended to adapt to many different viewing conditions including large-screen settings and touch devices.

Keywords: responsive web design, interface-driven web engineering.

1   Introduction

Application developers in general, and web site providers in particular, currently have to deal with the increased range of new devices and diversity of interface characteristics, not only in terms of screen size and resolution, but also supported input and output modalities. For example, the term "mobile" has traditionally been used to refer to small-form factor, handheld devices such as mobile phones and PDAs with limited screen size and processing power. However, nowadays, this includes a whole new generation of smartphones and tablet computers, such as the iPhone or iPad, that are becoming more and more powerful and commonly provide touch, gesture-based input and other advanced sensing techniques. There are also new kinds of medium-size devices, such as notebooks with support for slate mode, booklets and convertibles, that are often hybrid solutions, but still primarily designed for mobile settings. It is frequently the case that, as well as supporting traditional mouse and keyboard input, they increasingly provide support for an even richer combination of touch, pen and gesture-based input. Looking at the other end of the spectrum, even the term "desktop" may nowadays refer to a wide range of devices with a strong trend towards large, wide-format screens, and there is growing interest in physically much larger, very high-resolution display environments [1]. In addition, research has also suggested extensions of the desktop paradigm towards what has emerged

as the "tabletop". Many new kinds of large interactive surfaces have been developed and are now becoming commonplace in offices, public spaces and at home. With very small touchscreens [2] and new types of rollable devices [3], recent research has continued to explore different kinds of interaction techniques and is constantly pushing forward both input and output technologies. We can therefore expect an even greater diversification in terms of device characteristics over the coming years.

The rapid evolution and increased diversity of new devices used for web browsing has caused a major rethinking of design strategies. For many years, two strategies, *graceful degradation* [4] and *progressive enhancement* [5], have played a major role. Both aim at a layered approach towards multi-device authoring by adding either more or fewer layers designed for more or less advanced devices in terms of their screen size, input methods and other supported capabilities. Both also follow the well-established separation of concerns in web engineering by distinguishing the different levels of content, navigation and presentation typically using rule-based approaches for selecting appropriate layers. The main difference is that graceful degradation starts from a user interface designed for the "less constrained platform", removing features if the particular device in use does not provide the required support, while progressive enhancement adds layers to the core interface designed for the "lowest common denominator". The two strategies have therefore in common the fact that they try to divide the device landscape into linear partitions, but start at opposite ends of the spectrum. However, this approach has become less feasible nowadays due to the diversification of devices.

A new trend is therefore *responsive web design* [6] which means to build the layout of the web interface on fluid grids that can dynamically adapt to diverse viewing environments. At the technical level, this is achieved by using relative units (percentages or ems) rather than absolute units (pixels or points) for page element sizing as well as CSS3 media queries to apply different CSS rules for the position and floating of elements depending on the size of the browser window. Hence, responsive design promotes a specific way of implementing interfaces that is however difficult to apply to existing web sites without major reengineering [7].

The tutorial is divided into two parts. The first part provides an introduction to responsive web design as a new and significant trend in web development as well as a discussion of current issues. The second part gives an overview of existing, and our own, ongoing research to tackle the different issues in a systematic way. Practitioners not familiar with the concepts and technologies will benefit from the step-by-step introduction. For the ICWE research community, the tutorial provides interesting opportunities for discussing this new web design trend and the implications for web engineering.

2   Tutorial Synopsis

Using various examples, participants will learn about different methods and technologies for achieving responsive design. In particular, the new features of HTML5 and CSS3 will be discussed as well as the problems caused by the fact

that these standards themselves are still evolving. While desktop-to-mobile adaptation will be used as the running example in the first part of the tutorial to illustrate the concepts and steps involved in responsive design as a web design method, it also shows the benefits and limitations compared to other context-aware adaptation approaches that have been promoted in research. Specifically, there is an interesting tension and contrast between the interface-driven approach behind responsive web design and model-driven web engineering which has great potential for discussion in the ICWE forum.

The second part of the tutorial addresses some of the issues of responsive design, both from a technological point of view and as a web design method, based on our previous research [8]. First, we present languages, frameworks and tools developed by us and other researchers that tackle the issues of context-aware adaptation at the implementation level. Second, we show how crowdsourcing can be used for the adaptation and evaluation of web sites to make the design and development for the increased proliferation of different forms of devices practical. Finally, we present a set of metrics for measuring the adaptivity of web interfaces and guiding web developers in the adaptation process in order to address contexts of use that are still poorly supported by current design. The methods and tools presented in the second part go beyond the principles of responsive design, not only from a technological and methodological point of view, but also in terms of scenarios and use cases. In particular, we show how the techniques were extended to cater for adaptation to large-screen displays and multi-touch devices as well as distributed interfaces and interaction in multi-device environments.

Therefore, participants will not only receive an overview and introduction to the current trend of responsive web design, but also a sense of the shortcomings of the approach and current issues. For researchers, we highlight interesting opportunities for further research when looking at responsive design in the broader context of web engineering.

Biographical Sketch

Michael Nebeling is a Post-doctoral Researcher and Lecturer at ETH Zurich. His research and teaching interests are at the intersection of Web Engineering and HCI, including context-aware and adaptive systems, multi-device and gesture-based interaction, end-user development and crowdsourcing. His PhD thesis, *Lightweight Informed Adaptation: Methods and Tools for Responsive Design and Development of Very Flexible, Highly Adaptive Web Interfaces* [8], has made several contributions to ICWE and has won best paper awards and nominations at CHI 2011 and EICS 2012.

Moira Norrie has been a Professor at ETH Zurich since 1996 when she established a research group on Global Information Systems. She heads the Institute for Information Systems which is part of the Department of Computer Science. Her main areas of research are information systems engineering, information interaction, web engineering and personal information management.

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