Supporting Display Scalability by Redundant Mapping

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Abstract. Visual analysis sessions are increasingly conducted in multi-display environments. However, presenting a data set simultaneously on heterogenous displays to users is a challenging task. In this paper we propose a two-step mapping strategy to address this problem. The first mapping step applies primary mapping functions to generate the same basic layout for all output devices and adapts the object size based on the display characteristic to guarantee the visibility of all elements. The second mapping step introduces additional visual cues to enhance the effectiveness of the visual encoding for different output devices. To demonstrate the Two-Step-Mapping we apply this concept to scatter plots presenting cluster data.

1 Introduction

Smart environments integrate a multitude of interconnected devices to facilitate a pro-active assistance for multi-user scenarios. Those ensembles consist of stationary devices such as desktop devices, projectors, motion trackers, or wall-sized displays, but also aim to integrate personal devices of users such as laptops, PDAs and smart phones. Smart meeting rooms are a typical application scenario of smart environments [1] serving as a basis to communicate information to facilitate discussions and to support decisions.

However, in [2] the challenge of *Display Scalability* has been described dealing with the consistent visual encoding of the same data on different output devices such as smart phones, laptops or large public displays (see figure 1). The problem to be solved here is related to this challenge and in particular aims to avoid the following problems:

- On *small displays*, visual clutter may occur and
- on *large public displays* connectivity information can be lost.

This means, simultaneously presenting the same information on different output devices is a challenging task to be solved in smart environments.

In this paper, we address the problem of *Display Scalability* through extending the classical visual mapping to visual variables (which we call primary mapping) to a redundant encoding of data (which we call secondary mapping).

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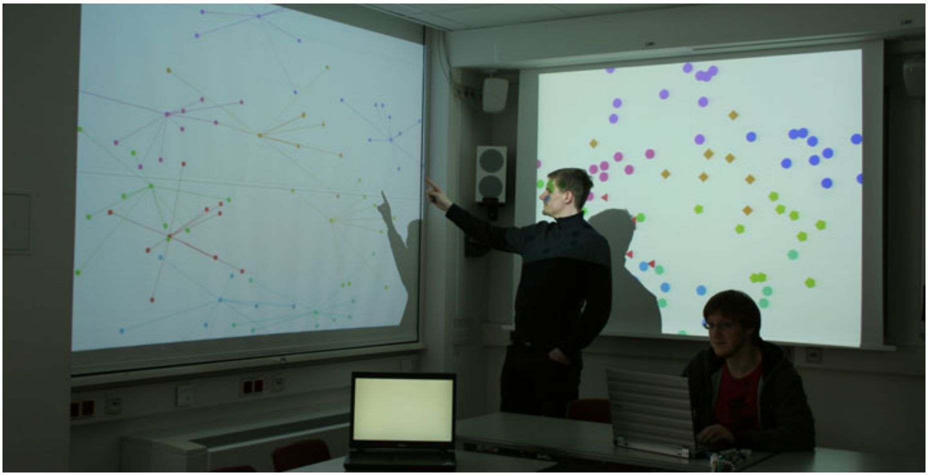

Fig. 1. Applying the proposed Two-Step-Mapping to generate scatterplots showing the same clusters on different display devices in our smart meeting environment

We will demonstrate this approach using the example of presenting clustered data in scatter plot displays.

The paper is organized as follows: First we briefly reflect the state of the art in Section 2. In Section 3 we introduce the two-step mapping strategy and exemplarily show the application to scatter plots presenting classified data. Section 4 describes a short user-study and Section 5 concludes and gives an outlook on further work.

2 Related Work

Visual representations have been adapted in multiple ways to address different data properties (e.g., [3,4]), different visualization goals (e.g.,[5,6]) and different user capabilities (see [7]). However, the generation of proper visual representations in consideration of heterogeneous multi-displays, as they are found in smart environments, has not been sufficiently examined. Such environments are generally heterogeneous ensembles, that change over time (joining and leaving devices) and facilitate collaborative work (e.g., in [8,9]). The specifically developed, rare visualization approaches for those ensembles typically combine the individual displays into a large single one. Thus, current research mainly addresses the problems of *sharing* content synchronously from multiple devices on multiple displays and *sharing* the corresponding multiple interactions on the devices (e.g., [9,10]). Other research projects in the field of multi-desktop environments study the effectiveness of such environments (e.g., [11]) or of single display types (e.g., [12]). However, they do not provide a strategy on how to adapt the same visual representation to different displays.