

DiRec: A Distributed User Interface Video Recommender

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ABSTRACT

Distributed User Interfaces (DUIs) are graphical interfaces whose components are distributed in one or many of the UI distribution dimensions: Time, space, platforms, displays, or users. In this work, we have investigated the impact of the application of DUIs, with respect to the different DUI dimensions, on the experience of users of recommender systems. We developed two prototype video recommendation mobile applications: Monolithic Interface Recommender (MiRec), and Distributed Interface Recommender (DiRec). Sharing mostly the same interface, DiRec additionally offers the possibility of migrating parts of the UI between the mobile application and a larger display (LD). A user study was conducted in which participants used and evaluated both MiRec and DiRec. Our results show a significant difference between DiRec and MiRec in attractiveness (general impression and likability), stimulation, and novelty measures, which posits the existence of a strong interest in DUI recommender systems. Nonetheless, MiRec was found more easy-to-learn and easier to understand than DiRec which gives room for further investigation to pinpoint the reasons of DiRec’s relatively lower perspicuity measures.

CCS Concepts

•Human-centered computing → User interface design;

Keywords

Distributed User Interfaces; Recommender Systems; Migratable Interfaces; Mobility; User Study.

1. INTRODUCTION

With the advancement of ubiquitous computing and the trend of the ever-increasing number of devices per user, users of interactive systems no longer perform tasks that reside mainly on a single device, but are rather confronted with situations where they need to complete tasks across several

platforms. A typical situation is a user carrying out tasks in a multi-device environment that presents itself effectively to the user as a single UI, but which is actually distributed along these platforms. Such situations represent typical cases of Distributed User Interfaces (DUIs). Hence, DUIs represent an attempt to overcome the limitations of user interfaces that are manipulated by a single user, on a single platform, in a fixed environment, providing few or no variations along these distribution dimensions.

To our best knowledge, surveyed studies for the applications of DUIs do not include any which tackle single-user recommender systems; the fact that provided the main motivation for this research. We hypothesize that the distribution of recommender systems’ UIs leads to an enhanced user experience. To verify our hypothesis, we developed two high fidelity prototypes for video recommendation: Monolithic Interface Recommender (MiRec), which is a conventional mobile video recommendation application, and Distributed Interface Recommender (DiRec), which is a distributed version of the mobile video recommender where the interface is distributed among a mobile device (SD) and a large-display screen (LD).

The proceeding sections describe this research’s main contributions: A proposal for a generic model for UI distribution for recommendation applications, the design of DiRec which is considered as an instance of this generic model, as well as the results and conclusion of a user study that was conducted to test the impact of our DUI recommender’s design on users’ experience.

2. BACKGROUND AND RELATED WORK

Enhancing the experience of users of recommender systems through developing more sophisticated recommendation algorithms, taking in consideration aspects such as the novelty, diversity, and accuracy of recommendations, has become the focus of many recent studies. However, fewer studies investigate the possibility of enhancing the user’s experience through providing novel UI solutions for recommenders. None of the surveyed research has considered the impact of the distribution of the UI of recommenders on the user’s experience. This is where our study provides its main contribution.

During the course of our investigation, we surveyed many studies that laid the foundation of the relatively new field of DUIs. Mostly relevant to our study is Vanderdonck et al. [9]’s description of what constitutes a distributed UI environment: “UI distribution concerns the repartition of one or many elements from one or many user interfaces in

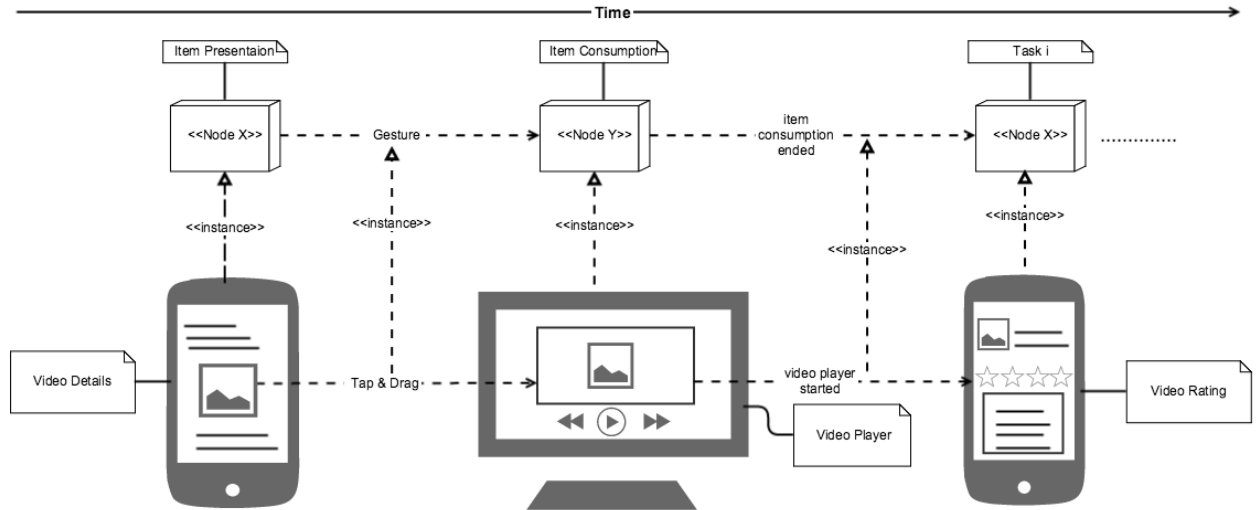


Figure 1: Recommended video consumption and rating as an instance of the generic DUI model.

order to support one or many users to carry out one or many tasks on one or many domains in one or many contexts of use, each context of use consisting of users, platforms, and environments.” To deepen our understanding of the various dimensions of UI distribution, we surveyed several studies ([2], [3], [5], [9]). However, one that has been especially relevant to our study is the 4C model described by Demeure et al., through which we could define the 4Cs of our proposed DUI recommender: Computation (what is distributed?), in other words the element of distribution, which could be the task or the platform, Communication (when is it distributed?) or time, Coordination (who initiates distribution?) which is a variation on the user dimension, and Configuration (from where and to where is the distribution operated? on the physical pixel level, or the logical level) [2].

On the other hand, a number of studies have found DUI techniques useful for their applications among which are IAM [1], Aura [7] and ConnecTables [8].

For implementation of our DUI recommender, we adopt a dual display (SD-LD) approach which is similar to Kaviani et al’s, who argue that the use of ubiquitous cell phones as an SD component in a DUI not only offer a means to interact with LD displays, but increasingly offer a small, but high quality screen to complement the LD [4].

Moreover, in our previous work [10], we investigated the application of DUIs in group recommender systems. We developed a scenario of a movie recommender, where the UI is distributed among two platforms: a PDA that works as a small display (SD) and a table-top that works as a large display (LD). Users get to view and rate recommended items on their PDAs individually, and as a group, they get to reach a consensus by doing the voting on the table-top. This DUI solution to the voting part of group recommendation is proved by the study to improve the process of reaching consensus among a group. This study takes a further step by investigating the benefits of using DUIs in single-user recommender systems.

3. DESIGN OF A DUI SINGLE-USER RECOMMENDER

Scenarios of our DUI video recommender depict a multi-device environment, in which the flow of control (logic) and the application’s user interface are decoupled in a way that allows for the distribution of UI components along the different devices. In other words, the user of such a system is provided with a distributed solution, which enables him/her to perform tasks on whichever device in this environment (by for example migrating the UI components between the different devices) independently of where the application is running, and of the constraints presented by the different platforms running the application.

3.1 Generic Model for UI Distribution

The following are generic scenarios for UI distribution of interactive systems that are applicable to recommender systems:

- *Migration of Item Consumption*: present the recommended content on one device while giving the user the ability to consume the content on another device.
- *Performing Parallel Activities*: user can perform tasks simultaneously and independently from each other.
- *Overview and Detail Presentations*: show different versions of the presented content at different levels of granularity on different nodes.
- *Content Filtering*: distribute the task to filter the user’s choice of what to consume.
- *Content Redirection*: content could be transferred to be presented on a different node.
- *Migration of Items Between Users*: content redirection/migration of a list of recommended items (or an item in this list) from one user of the system to one or more other users.

We will describe more specific scenarios that can be considered as an extension of this generic UI distribution model (Figure 1) in a distributed video recommender application in the next subsection.

3.2 DiRec: Distributed Interface Video Recommender

We assume the users are working with a smaller (SD), e.g. a smartphone or other mobile device, and a larger display (LD), e.g. a display screen.

3.2.1 Pre-Configuring UI Distribution Options

This scenario presents the initiation point of the system, in which the user is given an option to pre-configure the different options the system offers for UI distribution, and hence be the initiator of UI distribution. This offers the ability to delay the decision of which UI components to present on which platform, making the system distributed in time. This is made possible by presenting the user with a Meta UI in which he/she is asked to drag and drop the components of their choice to the target platform.

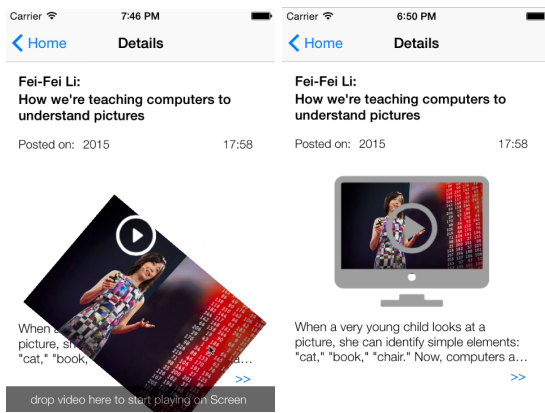


Figure 2: Redirecting recommended item consumption from SD to LD.

3.2.2 Presentation of Recommendation Results

The presentation of recommended videos is shown in parallel on the SD and LD, however, in different levels of granularity. The mobile device shows a detailed list of all the recommended videos, together with detailed information about the video, in tabular form with different categorizations. On the LD, an overview presentation is shown for the recommended items that scored the highest for the user without details, however shown in different sizes to indicate the recommendation scores.

3.2.3 Recommended Item Details Presentation

Moreover, in our proposed design, we offer the possibility of distributing parts of the UI with a fine granularity. The user selects a single table-cell in the videos list and could move it to the LD by applying the gesture, as opposed to just mirroring or transferring the UI at a more coarse granularity.

3.2.4 Recommended Item Consumption and Rating

Starting a video on the LD is done as depicted in Figure 2 in our prototype. On the video details page on the mobile device

(SD), the user performs a pan gesture on the video image, which then triggers the migration of the video consumption from the mobile device to the LD.

The video player automatically starts on the LD, providing the user with all controls for the video playback. After the video playback starts automatically on the LD, the LD triggers the mobile device to display the rating page for the user on the SD. Hence, the two tasks could be carried out simultaneously by the user (Figure 3).

3.2.5 Filtering Recommended Items

Filtering is done by performing a right swipe gesture on the video item in the list on the SD which redirects the content of the video to the LD. The display of the content on the LD is also done in an overview-detail coupling manner. After the user is done filtering the LD will contain all the selected items displayed as an overview.

3.2.6 Redirecting Favorites Lists

Unlike previously described scenarios which involve a single user of the system, this scenario involves two or more users. On the SD, the user selects a favorite-items list. On applying a long-press on the list, the user is prompted with a list of users from which he could select one or more users to transfer this list to.

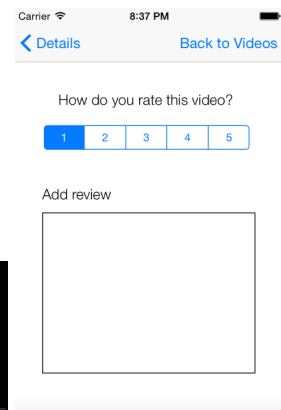


Figure 3: Rating a recommended video on SD in parallel to watching it on LD.

3.3 Prototype Implementation

A subset of the suggested distribution scenarios was selected for implementation. MiRec is developed as the non-distributed version of DiRec and is meant for comparison with DiRec's interface through our comparative user study. Both applications share mostly the same design, however, thorough DiRec, the user could complete tasks in a distributed manner between a mobile application and a large display screen, while with MiRec, users could only complete tasks on the mobile device. MiRec is developed as an iOS mobile application while DiRec is distributed along an iOS application and an LD Python application with a communication layer in between which mainly relies on light-weight TCP-IP based message passing between both platforms (e.g.: play:<videoID> is passed from SD to LD in DiRec to play a video on LD).

4. USER STUDY

To evaluate our approach, we have conducted a user study in three phases. 24 participants were asked to use both MiRec and DiRec and rate their experiences of the products using the User Experience Questionnaire (UEQ) method [6] shortly after finishing the test.



Figure 4: Participant's interaction with DiRec.

4.1 Setup

Each participant was first briefed about how to use MiRec and DiRec, then he/she was asked to complete a set of tasks on both applications including navigating recommendations' lists, playing and rating of videos. Each participant was given an iPhone with both DiRec and MiRec installed and was being asked to interact with the LD screen component during the course of the experiment (Figure 4). During the last phase of the experiment, participants were asked to give their direct impression of the application using the UEQ method [6]. UEQ consists of 6 scales with 26 items which measure Attractiveness (overall impression or the likability), Perspicuity (learnability and ease-of-use), Efficiency (the ability to perform tasks without exerting extra effort), Dependability (user's control over the experience), Stimulation (excitement and motivation) and Novelty (innovation and creativity).

4.2 Results

Figure 5 shows the result of UEQ's comparison of MiRec (left side, blue) and DiRec (right side, red). With respect to attractiveness, stimulation, and novelty, DiRec scores higher than MiRec. For efficiency and dependability, they measure almost similarly with MiRec scoring slightly better than DiRec. MiRec, however, scores much higher than DiRec when it comes to the perspicuity scale. Conducted t-Tests showed statistical significance with regard to perspicuity ($\alpha=0.0092$), stimulation ($\alpha=0.0007$), and novelty ($\alpha=0.0000$), but no significance for attractiveness, efficiency and dependability with an alpha level of 0.05.

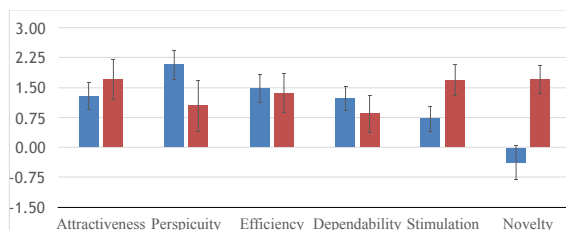


Figure 5: Comparison of scale means in MiRec (left/blue) and DiRec (right/red)

5. CONCLUSIONS AND FUTURE WORK

This work investigates the impact of using distributed user interfaces on the experience of users of recommendation applications. Our comparative user study's UEQ results could be interpreted as follows: The use of DUIs aids the stimulation and novelty of recommendation applications, hence, enriches the user's experience, does not hinder the efficiency or limit the span of the user's control of recommendation applications, results in more attractive recommendation applications, however, might affect the learnability and ease-of-use of recommendation applications. Notwithstanding the promising results of our study, the study has fallen short in providing an explanation of whether the relatively lower perspicuity measures of DiRec is a result of insufficient explanation of the study's procedure, or if it was DiRec's design that was relatively less easy to understand and learn. A possible future work would be to further investigate this aspect. Lastly, we strongly believe that giving more span of control to the user through allowing pre-configuration of UI distribution schemes could further enhance the DUI experience.

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