Navigating Product Catalogs Using 2+1D Fisheye Browser

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Abstract:
This paper introduces a novel user interface of online product catalogs. Our research focused on its capability for helping shoppers to navigate and analyze online product information. Specifically, we discuss the application of a new multi-level focus+context visualization technique, called 2+1D Fisheye Browser, in the design of interactive visual interface which can be used to assist buyers in navigating online product catalogs which contain large number of products. The 2+1D Fisheye Browser uses an ordinary 2D Hyperbolic Tree Browser to display the major structure of hierarchies while a 1D distortion-based Fisheye Menu is also used to assist the display of those sub-hierarchies containing large number of leaf nodes. We implement this technique as a visual product catalog of an online Grocery Shop. This Grocery Shop system simulates the experience of online shopping. It is applicable to any e-commerce shopping application.

Keywords:
e-Commerce, Online Product Catalog, Shopping Cart, Focus+Context Viewing, Hyperbolic Tree Browser, Fisheye Menu.

1. Introduction

Over the past few years, e-commerce over the Internet has emerged as a dramatic new mode of business. The core of an electronic merchant's content is the online product catalog, which typically includes information, such as product descriptions, prices, availability, and other details. It provides sellers with a content management system that stores, indexes, aggregates, normalizes, and distributes product information. It also provides potential buyers with an interactive interface that offers a multimedia representation of the product information as well as classification and navigation services.

A lot of research work has been done for both types of customers of B2C e-commerce. For content management, a number of commercial products have been developed, such as *Interwoven* [1], *Poet Software* [2] and *Vignette* [3], and are used by many e-commerce web sites. For catalog interfaces, various methods supporting product search and navigation have been developed [4]. These product information navigation methods are sometimes referred to as *shopping metaphors*. The usability of several product selection mechanisms was studied in [4, 5]. Also, the impact of different shopping metaphors on the effectiveness of online stores in terms of click-through and conversion rates was analyzed in [6, 7].

While these product catalogs can effectively assist the sellers/buyers in managing, searching and accessing product information through the WWW, they usually do not provide a 2D graphic user interface that gives buyers a sense of information "space". Typical online product catalogs are comprised of a series of textual product list pages, Web pages that provide information about one or more products being sold. Each page usually only provides information about a small number of products (see Figure 1), e.g. one to ten products, which tend to belong to the same or a similar product category. As a result, shoppers normally need to browse and read multiple product pages in order to accumulate information about the products of interest when s/he is exploring through a large product hierarchy by following the embedded hyperlinks. The buyer has to click through many pages to move down/up the product hierarchy to find appropriate products s/he needs. This scenario always happens that a buyer develops a cramp in her/his hand and although s/he still has a few more pages of items to look at, s/he

decides to just buy one of the items s/he has already written down. Her/His mood at the ending of her/his shopping experience could be described as somewhat frustrated. Thus, the entire structure of the product hierarchy is split into many small pieces and it is very difficult for buyers to perceive the overall structure of the product hierarchy by reading these textual lists which are located in a sequence of pages. In fact, the effectiveness of this navigation mechanism in terms of click-through, HTTP network transaction, and human cognition is lower.

Figure 1. Grocery express - A traditional product catalog for online e-commerce that provides buyers with a series of textual lists placed in separate pages for navigation.

We can see from the picture in Figure 1 that the traditional online product catalog facilitates the navigation of the product information space. However, it of course, increases the network traffic by using the click-through scheme. It was reported that navigation problems are the second most cited reason for not shopping online (after security concerns) [8]. Online catalog interfaces should allow rational buyers a high level of analyzability by providing the ability to easily navigate through the product information space and locate information of interest. In recent years, some techniques of information visualization have been introduced into this area. These techniques attempted to provide users with a 2D interaction space that could give users an overall view of product hierarchies for the navigation of product catalogs. A typical example of such techniques is *Hyperbolic Tree Browser* [9] developed by *Inxight Co.* and *Xerox PARC* (see Figure 2).

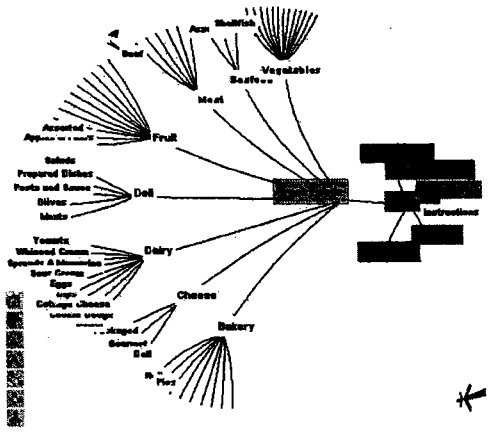

Figure 2. An example of using a Hyperbolic Tree Browser to navigate product catalogs.

HT Browser uses a focus+context viewing technique based on hyperbolic geometry for visualizing and manipulating large hierarchies [10]. It assigns more display space to a specific portion of the hierarchy where the user is currently focusing on. This allows users to see more detail of the portion he/she is interested while still showing the context of the entire hierarchy in the same picture. It lays out the hierarchy in a uniform way on a hyperbolic plane and maps this plane onto a display region. It provides a fisheye distortion on the chosen area of the interest that supports a smooth blending of focus and context. It also has effective procedures for manipulating the focus using pointer clicks, as interactive dragging, and smoothly animating transitions across such manipulations.

While this technique effectively deals with catalogs of moderately large size, it does not consider the issues of optimizing the use of display space and balancing the display areas for placing context and focus in the visualization design. For example, when we use a hyperbolic tree browser to navigate the hierarchy, in many cases the display space is not fully used efficiently and the distorted tree display can often leave one or more empty holes in the display. Especially when viewing a sub-tree with a large number of children (in online retailers or marketplaces, it is quite possible for a sub-category of product catalog to have a lot of concrete products.), it will waste a large portion of the display area and reduce the number of

components (nodes and edges) that can be displayed on the screen greatly, see Figure 3. Furthermore, the distorted tree display can often break the balance of display areas for displaying context structure and focus structure.

For example, when we use a hyperbolic tree browser to display a product catalog and focus to a particular sub-category node "Vegetables" with 50 leaf nodes under, as show in Figure 3. We can see that there is a big empty hole generated in the center of the applet that wastes a large portion of the display area. Even if the context view is pushed into the corner, there are still many overlaps among the leaf nodes. Thus, the labels of some leaf nodes become invisible and the quality of the visualization is greatly reduced. Another problem in the visualization shown in Figure 3 is that the context view is pushed into a very small area and becomes unbalanced with the focus view which occupies about 80% of the display space. This small area can only display nine nodes and such a meaningless context view cannot give users an overall view of the complete hierarchy they are navigating.

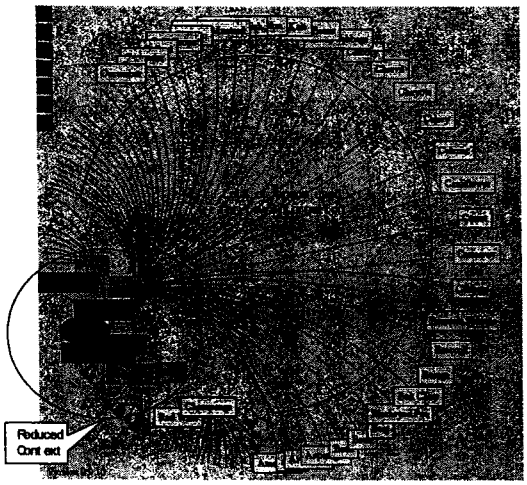

Figure3. An example of using hyperbolic browser to viewing a sub-category with many leaves. We see that a big empty hole is generated in the center wasting a large portion of the display area, and the context view is pushed into the corner and becomes meaningless.

In this paper, we present a new multi-level focus+context technique, called "*2+1 Dimensional Fisheye Browser*" *(2+1DF-Browser)* for visualizing large hierarchies, especially for those that contain large number of leaves. We use the combination of a 2D fisheye distortional visualization technique and a 1D fisheye distortional menu to improve the utilization of display space and to balance between two views: the *context view* and the *focus view*. In practice, we use an ordinary 2D Hyperbolic Tree Browser as a backbone of the visualization to view the major part of the hierarchy while an additional 1D distortion-based Fisheye Menu [11] is used to assist the display of sub-hierarchies that contain a large number of leaf nodes. Because fisheye menu can fit large number of data items (leaves of the hierarchy) in a predefined fixed sub-window by dynamically adjust the font size and the focus zoom. It does not require extra display space when the number of items grows. This promises the 2D visualization can have more display space for a higher quality display of context. This dual focus+context visualization mechanism effectively addresses the problem of display large number of leaves under a particular parent node in many real world situations, such as the product catalog of a grocery shop, which we will give the implementation in our paper below as an example.

2. The Framework of 2+1D Visual Online Grocery Shop

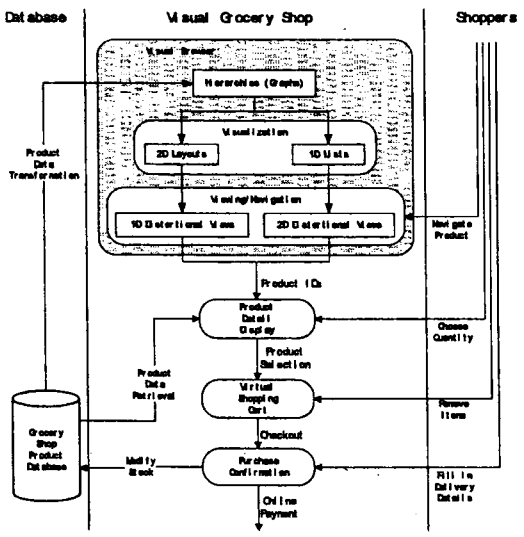

Figure4. The Framework of 2+1D Visual Online Grocery Shop.

The *Visual Grocery Shop* consists of several components. These components and inter-relationships among them can be described in Figure 4; Details are explained below:

- Visual Browser:
  An interactive graphics that can be used to display and navigate the product category works as an advanced product catalog. The product information is processed through a series of transformations from its analytical abstraction (graphs) to its visualization abstraction (a 2D geometrical layout + several 1D lists), and then to its navigate-able views (several fisheye distortions) which are finally presented to the shoppers. In our framework, there are two levels of navigation: a 2D interactive visualization is responsible for the navigation of the upper (none leaves) level structure of the hierarchies, and a 1D interactive visualization is in charge of displaying and browsing lower (leaves) level structure of the hierarchies.

- Grocery Shop Product Database:
  A relational database used to store product information, including all data fields and attributes associated with a particular product that is available for sale in the online shop.

- Product Detail Display:
  A web page generated on the server side by a scripting language (we use a PHP script in our implementation). It retrieves the appropriate product entry from the database table corresponding to the mouse-click on a particular leaf node or menu item in the 2+1D Fisheye Browser. It then displays the attributes of the selected product on the page. Each product displayed has an associated "Add" button and an associated "Quantity" text field. The "Quantity" field allows shoppers to fill in the number of product they want to purchase, while the "Add" allows shoppers to add selected product to the virtual shopping cart.

- Virtual Shopping Cart:
  A core element of the shopping-cart e-business model, which can be written in server-side scripts, such as PHP, ASP or JSP. This shopping cart is responsible for controlling the buyer selection of products and the checkout operation. It shows how many products are already chosen and the total value of the chosen products in the cart so far.

- Purchase Confirmation:
  This component displays a purchase form asking buyers to fill in their delivery details (including name, address, suburb, state, country and email address). All these fields must be completed for the order to go ahead. The user completes the transaction by clicking on a button labeled "Purchase". The details of the order are sent via email to the email address given on the form. It then retrieves the product database, recalculate the product stock and modify the in-stock field of those relevant product entries.

- Online Payments:
  There are many existing online payment systems available now, and implementation for each one is different. In this framework, we use a dummy function that can be replaced with a chosen online payment system.

3. The Implementation

In this implementation, we are designing an Online Grocery Shop. We use visual one-page catalog interactive interface for online product catalogs. It facilitates navigation of the product space and analysis of individual products. First, it presents the entire information space of offered products in a single web page. This compact display makes it easy to navigate through the product space and compare different products.

The layout of browser window (main page) is divided into three frames, the *Left Hand Frame*, the *Top Right Hand Frame* and the *Bottom Right Hand Frame*, as shown in Figure 5.

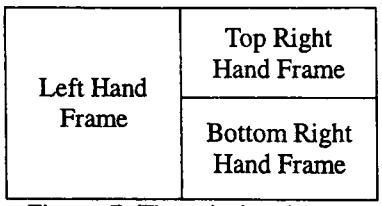

Figure 5: The window layout

The Left Hand Frame displays the 2+1D Fisheye Browser that shows a category hierarchy of products available in the shop.

The Top Right Hand Frame displays a web page generated on the server side by a *PHP* script. It retrieves the appropriate product entry from the *MySQL* product table and then displays selected attributes of the product on a web page generated by the script. Each product displayed has an "Add" button that adds the selected product to the buyer's virtual shopping cart, which is displayed in the Bottom Right Hand Frame.

The Virtual Shopping Cart shows the buyer how many products are already chosen and the total value of their selections so far. Buyers can empty the shopping cart (i.e. clear all selections made so far) by clicking on a "Clear" button. Buyers can also complete their shopping session by clicking on a button labeled "Checkout", When the Checkout button is clicked, the system checks that the buyer actually has products in the shopping cart, and if so it executes a *PHP* script whose results are shown in the Top Right Hand Frame.

The Checkout component displays a purchase form asking the buyer to fill in their delivery details (including name, address, suburb, state, country, and email address). All these fields must be completed for the order to go ahead. The user completes the transaction by clicking on a button labeled "Purchase". The details of the order are sent via email to the email address given on the form.

2+1D Fisheye Browser

The 2+1D Fisheye Browser comprises two parts: two-dimensional hyperbolic tree and one-dimensional fisheye menu. Both 1D and 2D visualizations use a distortion-based technique to achieve the context + focus viewing.

We implement the hyperbolic tree primarily according to the technique presented in [9]. For the sake of the habit of user browsing hierarchical structure, we lay out all nodes in a canonical direction, e.g. to the right in our example, as show in Figure 6. Then, when a node is brought to the focus, the display is rotated to have its children fan out in the right direction. Figure 6 shows the initial display of the product catalog with the root node placed at the center of the applet and the children of the root placed on its right side. Moreover, we use different colors as landmarks to present different levels of nodes in the hierarchy. Icons in the first column of the control panel displayed on the left corner of the applet are used to alter the attributes of layout and display, including the increase of label font size, decrease of label font size, increase of edge length, decrease of edge length, change of node's color, toggling node outline, display of more nodes, and display of less nodes.

In our implementation, we still use the hyperbolic tree to display leaf nodes, if a sub-category has 15 leaves or less. However, if a sub-category has more than 15 leaves, we then use red color to highlight the sub-category node, without further defining and displaying the sub-hierarchy in the 2D space, and use a fisheye menu to display and navigate the leaf nodes.

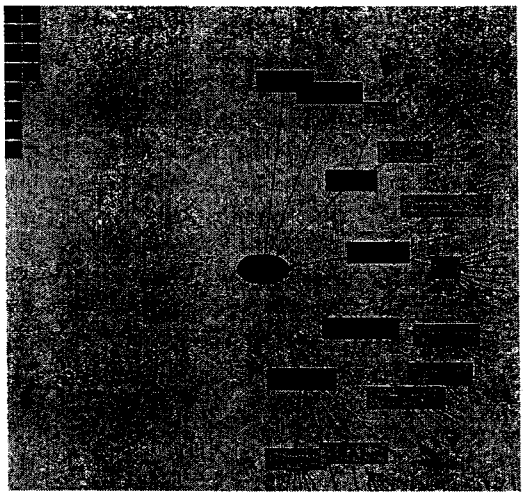

Figure6. An initial display of a product catalog using HT Browser with all children placed on the right side of the root.

For example, in Figure 7 we can see that there are three nodes 'Beer', 'Mineral Water' and 'Vegetables' highlighted with red color, which means that they have more than 15 leaves in their sub-trees. When you want to view the children items (leaves) of one of these red sub-category nodes, you need to move your mouse point over the node and drag the node to

an appropriate viewing position (see Figure 8), and then click the left button to popup a fisheye menu displaying all items of the 'Vegetables' sub-category (shown in Figure 9).

The Fisheye Menu applies traditional fisheye graphical visualization techniques to linear menus. It dynamically changes the size of menu items to provide a focus area around the mouse pointer. In fisheye menus, all of the elements are always displayed in a single window that is completely visible, but the items near the cursor are displayed at full size, and items further away from the cursor are displayed at a smaller size. In order to provide users with meaningful navigational information which help people target the portion of menu that contains the item they are looking for, we provide two types of the position information, the *Alphabetic Index* and the *Item Count*. We use the same alphabetic index mechanism as used in the ordinary fisheye menu proposed by B. B. Bederson [11]. This allows users to use their alphabetic knowledge jumping to the portion of the menu where they expect the item they are looking for to be. Besides the use of alphabetic index, we also display a sequential item numbers associated with index letters that indicate the numerical ordering of these items in the long list. These numbers also gives users the size information about the context (see Figure 9).

The items in the fisheye menu are the lowest level of the hierarchy. Individual nodes are "live". They represent particular products and they are live links to a *PHP* file. When a shopper clicks on a particular product node (e.g. "Cauliflower" in Figure 9), it will bring up a *PHP* file showing the details of the product in the Top Right Hand Frame of the browser window. Then shoppers can proceed to purchase or iterate the navigating procedure using 2+1D fisheye browser.

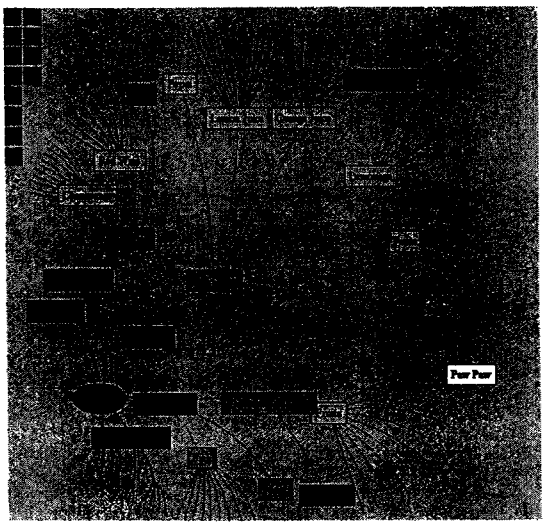

Figure7. Three red nodes 'Beer', 'Mineral Water' and 'Vegetables', presenting three sub-categories in the product-catalog and each sub-category has more than 15 items under.

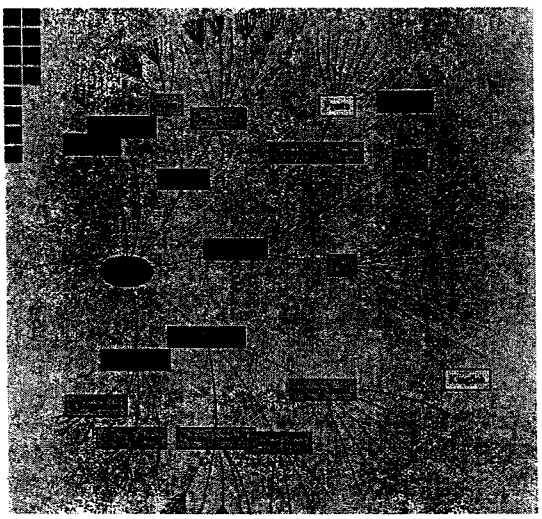

Figure8. Drag the node 'Vegetables' to an appropriate viewing position for displaying a fisheye menu that will list all items under the 'Vegetables' sub-category in a 1D distortional manner.

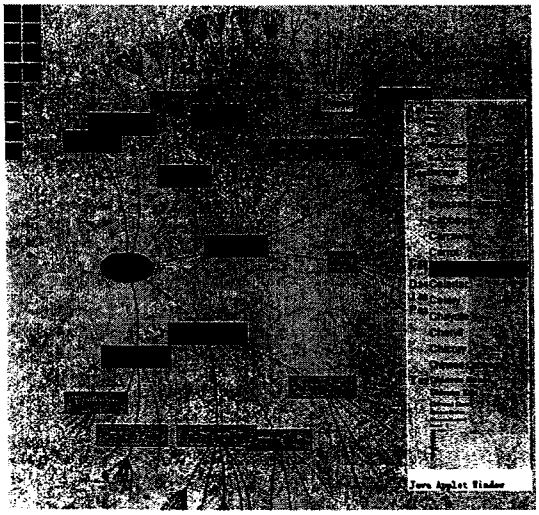

Figure9. A popup fisheye menu that displays all items of the 'Vegetables' sub-category in a distortional list.

4. Conclusion

Regardless of the specific business model (e.g., online retailers or marketplaces), an online shopper must somehow use an online product catalog to allow buyers to navigate through it for finding particular products s/he needs before actually purchasing or bidding for the product. Thus, the design of online product catalogs becomes the crucial part of B2C e-business, which directly influences to the effectiveness and efficiency of online business systems. When you design an online interactive product catalog, you should consider the following questions: 1) how easy is it for shoppers to find what they are looking for? 2) Is the catalog you designed with an easy-to-use user interface for navigation and understanding? 3) How many clicks does it take to get to a specific product? In this paper, we presented a new interactive visualization that can be used as online product catalogs, that provides a multi-dimensional interactive space allowing shoppers to visually navigate and manipulate the product hierarchies which contain large number of leaves with a sense of information space. This visualization presents the product catalogs visually within one page. The shopper can retain the overall structure of product hierarchy in the display during the navigation for a particular product. Our new navigation mechanism only requires a low rate of click-through and drag operations for the navigation, as the navigational structure of the product category was presented within one page. The parent-child relationships in the product hierarchies were presented by link-node diagrams and a distorted menu list that the user can percept them directly. All of these aspects make people shopping online easily and enjoyably.

However, this is just the beginning and there is a lot of research work in the future. We are interested in investigating other visualization methods that could be more appropriate to be applied in the fields of e-commerce. This will happen in the near future.

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