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Abstract

The purpose of this paper is to describe a multi-agent system for collaborative multimedia information retrieval in an electronic retailing application. We use content-based information (CBIR) retrieval for multimedia data including full-texts and images. Content-based image retrieval deals with retrieving data based on automatic content analysis as opposed to manual annotations, such as metadata specifications. While both collaborative agent technology and content-based information retrieval have been developed in previous research, few papers have attempted to combine both technologies in the same problem area. In this paper we describe a collaborative multi-agent system for multimedia information retrieval in an electronic commerce application.

Keywords: Software agents, content-based image retrieval, electronic retailing, electronic commerce, image analysis, computer-assisted sales

Introduction

Agent technology has been identified to have the potential to significantly enhance on-line shopping (for example Aylett *et al* 1999, Collis *et al* 1999, Nwana *et al* 1999). Agent-based commerce can help customers in locating the "best buys" with minimal effort, which in turn can benefit vendors by lowering their costs and increasing their customer base. Typically such systems consist of two types of agents: user agents and vendor agents. User agents typically need to identify a customer's preferences by asking pertinent questions and/or using covert techniques such as *adaptive profiling* (Soltysiak *et al* 1998, Ndumu *et al* 1999). Such user profiles play an important role in the effectiveness with which a sales agent can select and rank equivalent products without user arbitration. Once user preferences are identified, the user agent contacts vendor agents, communicates the user requirements, negotiates on product quality, suitability, and price, and filters the responses back to its owner.

The methodology presented in this paper can be applied to a number of different aspects of content management for an e-commerce applications (Neumann 2000). These include providing an efficient search mechanism through product catalogs, enabling an electronic sales agent to identify alternative product choices, and receive expert advice to make the "best" selections. Traditionally human sales agents have performed these functions in brick-and-mortar stores. There are several advantages of automating such tasks. For example, an electronic sales agent is not restricted to limited hours of operation, is capable of helping multiple customers concurrently, is able to process larger volumes of information in less amount of time, is less obtrusive, is less expensive, is not susceptible to mental setbacks if a sale does not go through, and can perform at a high level of efficiency for an indefinite period of time. On the other hand, an automated sales agent is not as flexible and may miss non-programmable cues that a human sales agent can pick up in special circumstances. There are further uses of a system such as this. For example, companies can manage visual information in electronic formats instead of relying on printed catalogs. Fashion designers can store and retrieve previous designs electronically, as well as create new designs efficiently. Such a system can also be helpful in *global sourcing*, which is an important issue in the textile and apparel industry (Lau *et al* 1998). Various members of the supply chain including fabric manufacturers, cut-and-sew plants, and retailers often need to look for different suppliers from large printed catalogs for different resources such as fiber, fabric, and apparel. An automated system for searching can significantly improve supply chain efficiency through streamlining communication and mid-course correction of production and procurement plans.

Several application areas for using multimedia have been suggested in the literature (e.g., Hoogeveen 1996, 1998) including Tele Sales assistance, multimedia business catalog, business promotion, multimedia aided instruction, and the virtual market. Several business objectives can be achieved by using multimedia systems: saving cost, improving access, increasing management control, improving quality of the catalog as a sales support tool, and higher learning effectiveness such as better retention and better understanding. In this paper we develop a methodology for using multimedia information in an electronic retail application. However, the methodology is not restricted only for electronic retailing but can be applied to many other application areas as well.

System Architecture

The system consists of two agents: shopping agent and vendor agent. The shopping agent collects user requirements and passes them to the vendor agent. The shopping agent has been implemented in Oracle Developer and is being ported to the Web using Oracle Developer server. The vendor agent retrieves one or more products based on their similarities with that of the user requirements supplied by the user agent. An image-processing module is used to analyze an image and obtain geometric features such as perimeter, area, minimum diameter, and maximum diameter, color histogram, and pixel intensities (Logic Vision 1999). The geometric features are used to compute shape parameters, which are subsequently loaded in a database. The image processing module also generates color histograms and pixel intensities and stores them as ASCII text files, which are then loaded into an Oracle database (version 8i) using the SQL*LDR utility. Subsequent processing of data is done using PL/SQL procedures and functions stored at the database server. The overall system architecture is shown in Figure 1.

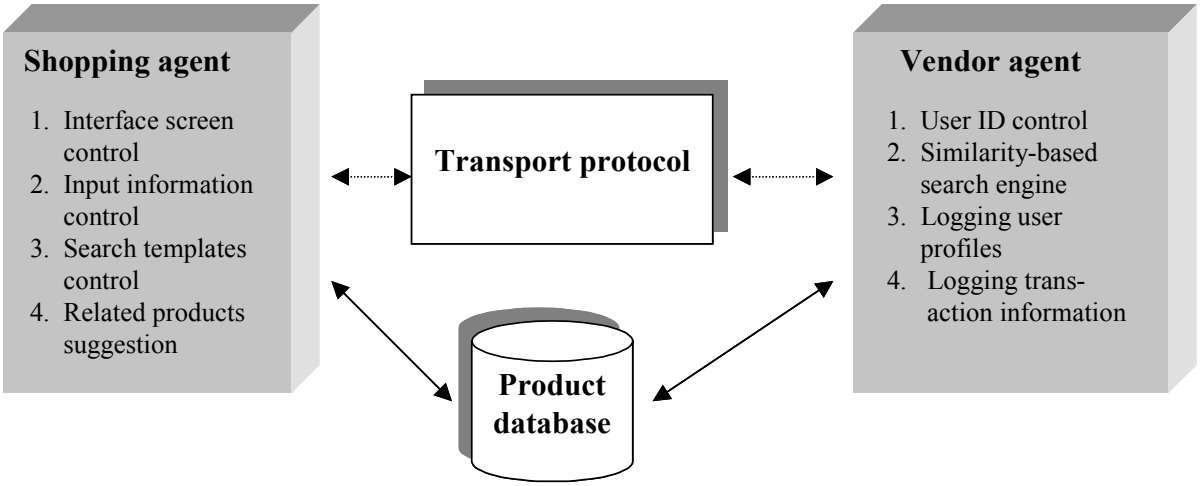

Figure 1. System Architecture

Shopping Agent

The shopping agent uses a Web-based system for interacting with end-users, who can browse through product offerings, search for products based on color and texture similarity, as well as shapes and sizes of prints. The system uses color as the default feature to be used in the absence of a user-defined feature. There are three ways that the system interacts with a user: assist the user to identify apparels based on visual characteristics and provide technical guidance by suggesting pieces of apparel that the user may want to consider along with an item selected by them. As an example of the technical guidance in purchasing decision, if a user is purchasing a dress shirt, the system suggests matching ties, trousers, jackets, and sweaters that could also be purchased as a bundle. It should be noted that the *matching* pieces of apparels are based on contrast as well as similarities. The main tasks of the shopping agent are listed below:

1. The main interface screen control: The main interface provides general information, any promotional information, and the main functions supported by the system.

2. Input information control: In this screen, customers can input information about their interests such as the name of goods, the brand names of the goods, the color, the texture, the shapes and the size, and any special requirement for the services such as required delivery times.

3. Search templates windows control: Since the color, texture, and shapes are hard to describe in words, so, the agent provides visual graphic assistance through templates, and the users need to use visual interface items to represent their interests. For instance, if a user wants a light gray shirt, she just needs to choose the closest one that matches her need in the assistance template.

4. Related products suggestion windows control: The agent can suggest related products to customers based on their selection.

Vendor Agent

The vendor agent takes the user requirements as input from the shopping agent and retrieves the relevant products. The relevancy of a product is determined by matching the characteristic features of the product with those of the user requirements. Product characteristics are based on visual features such as color, texture, and print patterns. We use two parameters to characterize shape: *surface regularity* and *roundness.* In addition, it is also possible to specify relative locations and topologies of smaller component shapes to create composite shapes. We use *color histogram* to characterize the color distribution of a print. For texture analysis, we use *contrast*, *coarseness*, and *directionality*. Besides shape, color, and texture, it is also possible to specify the sizes of printed patterns using *area* and *perimeter*. The details of the computation of the color, texture, and shape features are described in (Gangopadhyay 2001). The main tasks of the vendor agent are listed below:

1. User ID control: The agent provides the search functions by user ID and by guest. Through user ID control, the agent can track the user and log his individual profile and shopping habits in order to provide more personalized services.

2. Similarity-based search engine: This module provides special similarity-based search services. Especially when customers are unable to specify the exact name of what she wants and needs.

3. Logging customer profiles: This involves tracking the customer's interests and shopping habits and filing the individual profile.

4. Logging transaction information: This module logs transaction information, such as the user IP address and the user ID (if any).

Conclusion

The importance of streamlining supply chain management has been recognized in the textile industry through initiatives such as the Demand Activated Manufacturing Architecture (see http://www.dama.tc2.com/Pub/Final.htm). Such initiatives have the potential to reduce supply chain costs by billions of dollars by improving the information flow among supply chain partners. However, an important aspect of the nature of these products has been largely overlooked except in a few cases (such as reported in Lau *et al.*1998), which is the rich visual content of these products. In this paper we have described a multi-agent system for electronic retailing in the fashion, textile, and clothing industry. The system supports color, texture, and shape-based search for apparels, and enables "cross-selling" of products. The system has been implemented for electronic retailing, but can also be used in other parts of supply chain management such as design synthesis, forecasting of consumer demands, and inventory management by supply chain members. Such a system is also potentially useful for customer relationship management and personalization. In addition to business-to-consumer e-commerce, an electronic catalog can also use this methodology for business-to-business e-commerce by providing a visual communication medium for products with visually rich attributes that are difficult to express in textual descriptions.

The future plans for the system is to extend it with an interactive virtual apparel platform that would store physical characteristics of potential virtual shoppers and provide an interactive "virtual fitting room" with different backgrounds. Such a system can also be useful for other supply chain members to plan production schedules based on demand forecasts that can minimize inventory cost and maximize profit. We are also working on developing a plan for validating the methodology described in this paper by measuring its effectiveness in electronic retailing applications.

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