# SHOPPER'S EYE:

# Using Location-based Filtering for a Shopping Agent in the Physical World

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## 1. ABSTRACT

**Agents of all types rely on easily computed features that are suggestive of a user's preferences and goals to define and constrain their tasks. Although a person's location is usually suggestive of their current activity, agents have not relied upon a user's location to constrain their task. This is because users have typically used their computers only from home or work, and because location has not been easily computable. However the explosive growth in the use personal digital assistants (PDAs), laptop computers, and global positioning system (GPS) receivers is enabling people to use computers in the most remote of locations, and to have their location accessed by software.**

**This paper introduces Shopper's Eye, a PDA-based, GPS-enabled agent prototype that relies on knowledge of a shopper's physical location to support the shopping task while shopping at a mall. Shoppers indicate their shopping goals to Shopper's Eye. Then, as shoppers stroll through a mall, Shopper's Eye informs them of the availability of items of interest to them available in the immediately surrounding stores, as well as any cheaper local alternatives. Knowledge of both the user's goals, and the environment in which they act is a powerful combination that enables Shopper's Eye to bring relevant information to the user throughout the course of their task.**

**We begin the paper by introducing the concept of *location-based filtering* – exploiting the user's location to constrain the task of an agent. We then discuss how this technique is applied in support of *physical shopping*. We conclude with a discussion of the Shopper's Eye project and a description of the current Shopper's Eye prototype.**


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### 1.1 Keywords

Location-based filtering, GPS, shopping, PDAs, agent.

## 2. LOCATION-BASED FILTERING

A central issue for developing agents of all types is identifying easily computed features that are either very suggestive of the user's preferences and goals or can somehow be used to constrain the task of the agent. Keyword-based approaches are commonly used. For example, users may be asked to specify keywords to explicitly identify their goals [6], or keywords and key phrases may be extracted from user data [9]. *Collaborative filtering*, another technique, involves extending user

specified preferences by incorporating those of other users whose preferences overlap [8]. The *demographic generalization* method involves classifying a user using minimal user input into demographic categories with well-understood preferences [7]. These techniques are all intended to infer as much as possible about a user's goals and preferences based on observable features, while minimizing the need for user input.

This paper introduces Shopper's Eye, an agent that exploits a feature that, to our knowledge, has not yet been applied to information gathering agents: the physical location of the user. SHOPPER'S EYE is an agent running on a PDA (personal digital assistant) equipped with a GPS (global positioning system) receiver, intended to support shopping in an outdoor mall. This agent assists shoppers by providing information about merchandise in which they earlier expressed an interest. As a shopper strolls through a mall, SHOPPER'S EYE alerts him or her to the availability of merchandise of previously specified categories in the surrounding stores, as well as any cheaper alternatives in the local area. Shopper's Eye exploits the user's precise physical location to filter the information it presents.

Web agents have not used physical location as a predictive feature because the locations from which users access the web have largely remained constant — typically their home or office. Moreover, location has not been a particularly easy feature to compute and unambiguously communicate to an agent.

However, the explosive growth in the use of laptops and PDAs signals an important change. As we begin to find ourselves bringing our PDAs and laptops everywhere we go, the particular locations we use them will increasingly reflect an important part of our current context. Furthermore, our precise location can now be passively and unambiguously obtained by software through the use of GPS receivers. Such receivers are becoming increasingly affordable and compact. Some are now available as PCMCIA cards.

Location has, of course, played a significant role in other areas research. Navigation, most obviously, has relied on the ability to detect and monitor location. Recent work on supporting user mobility in which personalized computing environments follow users to remote locations also rely on knowledge of a user's location [2, 3].

In these cases, however, *location is the problem.* That is, a vehicle must be guided from one point to another, or a computing environment must be replicated at a remote location. In SHOPPER'S EYE the user's location is used in a very different way. Rather than defining the problem, the user's location is a crucial piece of data that can be used to inform and constrain the information gathering task. The ParcTab based "location browser", which displays file directories and runs programs associated with particular rooms in an office, is somewhat similar in its use of location-awareness as a means of capturing the user's context [10].

## 2.1 The Predictive Value of Location

Our physical location is often very predictive of our current task. If we know someone is at a bowling alley or a post office we can reasonably infer their current activity. Knowledge of a user's current task largely determines the type of information they are likely to find useful. People are unlikely to concern themselves with postal rates while bowling, or optimal bowling ball weight while buying stamps. In addition, knowledge of the resources and obstacles present at a particular location suggest the range of possible and likely actions of someone at that location. This awareness of a user's possible and likely actions can be used to further constrain the type of information a user is likely to find useful. For example, knowledge of a restaurant's wine list could be used by a recommender system to constrain the wine advice it presents.

Knowledge of a shopper's precise location in a shopping mall is valuable to Shopper's Eye because it enables the identification of the stores immediately surrounding the shopper. The offerings of the stores closest to the shopper represent the immediate choices available to the shopper. Given that shoppers place a premium on examining merchandise first hand and that there is a cost associated with walking to other stores, the merchandise of the closest surrounding stores constitute the most likely immediate selections of the shopper. Consequently, among the most useful information Shopper's Eye can provide at any given time is the availability of merchandise in the surrounding stores that matches their previously stated goals.

We tend to move to different locations while performing many of our tasks. This suggests our immediate surroundings do not completely capture the full range of options we may have. In fact one of the main reasons for leaving a location is to perform an action that is not possible at our current location. Nevertheless, we do tend to address most tasks within relatively local areas. Thus while our immediate surroundings suggest the options we have available at a given point in time, a broader view of a location will often capture the options we are likely to consider over the course of a task. In the case of mall shopping, for example, the stores immediately surrounding the shopper represent the options available at that moment. Mall shoppers, however, are generally willing to travel to any store within the mall. Therefore the potential options over the entire shopping trip include all the stores in the mall. Accordingly, Shopper's Eye presents offerings of interest only from the immediately surrounding stores because these are the immediately available options. When asked for alternatives Shopper's Eye restricts itself to all the stores within the mall – the area within which the

shopping task as a whole is likely to be performed. Being alerted that a store hundreds or thousands of miles away sells the same merchandise for a few dollars less than the cheapest local alternative is of little value in cases when shoppers require a first hand examination of the merchandise in question or are not willing to wait for shipping.

# 3. PHYSICAL VS. ONLINE SHOPPING

It is tempting to argue that online shopping will soon become the predominant mode of shopping, pending only greater penetration of home computers, the expansion of online offerings, and better online shopping tools. It would therefore be a mistake to begin using location to support an activity that will become virtualized. Already we've seen the emergence of a number of software agents that support online shopping. For example BargainFinder [6] and subsequently Shopbot [4] both allow users to identify the cheapest source for a music CD, given a title. Similar programs have been developed for buying books, such as BargainBot [1]. These systems demonstrate the potential of electronic commerce web agents to create perfect markets for certain products. The success of these agents will encourage the development of similar web shopping agents for a greater variety of goods.

## 3.1 The Limitations of Online Shopping

Certainly online shopping will continue to grow and the trend towards more powerful online shopping agents will continue. Nevertheless, it also seems clear that no matter how sophisticated web-agents become, traditional *physical shopping* will continue to dominate the market for the foreseeable future. Several inherent difficulties of online shopping will ensure the continued reliance on physical shopping:

***Non-fungible goods***

Web-based shopping agents have typically enabled users to identify the cheapest price for fungible products such as books and music CDs. While this capacity to create "perfect markets" for such commodities is of great benefit to consumers, several difficulties exist that will complicate applying these approaches to arbitrary products.

Commodities are particularly well suited to shopping agents because it is easy to make comparisons between competing offers. Because commodities are fungible, one of the very few dimensions upon which they differ is price. Price therefore becomes the primary, if not sole, criterion upon which purchasing decisions are made.

As soon as we move beyond commodities, however, several other criteria become important. For example, how do we compare items such as sweaters, mattresses, or tables? In addition to price we care about the materials used, the color, how it fits and feels, and the workmanship. Similar problems apply to most other products.

***Imprecise goal specification***

A second, related difficulty lies in communicating our desires to an agent. Shopping agents are great if we know the precise commodity we want. We can simply enter the product by name. Unfortunately, if we don't have a specific item in mind when we shop, then the problem of conveying what we want to an agent becomes more difficult. For example, how do I tell an agent what kind of lamp I want for my living room?

***Undeveloped preferences***

Interfaces that allow shoppers to include descriptive features like price ranges, color, options, brands, etc, can help address the above problem, but they are not enough. Much of the time shoppers either haven't formed preferences or can't articulate their desires until after they've started shopping and had a chance to examine various examples of the target products.

***Shopping is entertainment***

People like to shop and do so without having a specific purchase in mind. One study found that 42% of consumers are "non-destination shoppers" that visit the mall primarily for leisure browsing and socializing (Kirtland, 1996).

***Shopping is sensory***

Even if we could effectively provide these details most of us would be unlikely to delegate a purchasing decision to such an agent. After all, many people are uncomfortable even trusting spouses to make appropriate purchases on their behalf. Most people want to see and touch first hand what they're considering before making a purchase decision. The few preferences we may provide an agent cannot replace this rich, first-hand experience. At best such preferences could be used to generate a candidate set for shoppers to consider.

***Instant Gratification***

Shopping is often a very emotional activity. People are pleased with their purchases and often can't wait to get home to try them out. The inherent delay between online purchases and their receipt is a significant issue to those who simply must take home their selections as soon as they see them.

In the end, consumers will continue to engage in physical shopping because of the limitations listed above. However, the fact that the task can't completely be delegated to software agents does not rule out a role for them. First, of course, as the success of programs such as BargainFinder have demonstrated, users find them useful for purchasing commodities when they know what they want. A second role, however, is to support the physical shopping task

itself, throughout the time that a person is engaged in it. This, of course, is the approach taken in the SHOPPER'S EYE project.

## 4. SHOPPER'S EYE

At first blush it may seem that SHOPPER'S EYE is subject to some of the same limitations as purely web-based agents. After all, why should it be any easier to communicate our goals to SHOPPER'S EYE than it is to a web-based agent? Why would our preferences be any more developed for purchases supported by SHOPPER'S EYE than a web-based agent?

A key difference between purely web-based agents and what we refer to as "physical task support agents" (i.e. an agent that supports a user engaged in a task in a physical setting) is that web-based agents are completely responsible for conveying all information that will be considered by the user. On the other hand, "physical task support" agents such as SHOPPER'S EYE can augment the approaches of web-based agents by referring to aspects of a user's environment. For example, it is not terribly important for SHOPPER'S EYE to convey richly the feeling of a particular sweater if the sweater is in a store thirty feet away. It need only refer the shopper to the sweater. The shopper will gain a much better appreciation of the sweater by trying it on than through anything that can be conveyed by the system. When too many products match an imprecisely specified goal for a web-based agent, a more restrictive search must be made. In SHOPPER'S EYE, however, many matches simply indicates there is a store that is likely to be of great interest to the shopper and therefore should be visited. Once inside, narrowing down the merchandise of interest in person will often be far easier than refining our goals on a web-based agent. Therefore physical task support agents like SHOPPER'S EYE can help users elaborate their preferences and identify specific goals by calling users' attention to aspects of their physical environment as a means of conveying information throughout the entire course of the task.

### 4.1 The Promise of Physical Shopping Agents

It is hardly surprising that physical shopping has been neglected by the agents community. After all, until very recently there simply was no reliable way to deliver customized information to individual shoppers in remote locations. However, the explosive growth of PDAs, and their increasingly sophisticated communications capabilities promise to make them effective channels of "just in time" information to users wherever they happen to be.

SHOPPER'S EYE is an example of an agent that supports physical shopping by exploiting the promise of this developing channel. We intend SHOPPER'S EYE to support all phases of the shopping task including:

- *Specification of goals*

  Shoppers begin by indicating at least the general category of merchandise they are interested in. These goals may be refined as the task progresses. Shopping agents need to enable the specification of goals at various degrees of specificity.

- *Exploration of Product Space*

  Before shoppers can make a selection, they need to become educated about what is available. Shopping agents can aid in this task by presenting various classes of offerings, reviews, demonstrations, etc. Physical shopping agents can augment this by providing shoppers with a tour of the locally available offerings.

- *Refinement of preferences*

  As shoppers learn what is available and examine the offerings their preferences evolve. Agents need to enable shoppers to refine their preferences over time.

- *Identification and comparison of candidate products*

  As shoppers begin to understand what they want and what is available they typically compile a list of candidates that will be considered more carefully. Agents should support the construction and maintenance of such lists and facilitate the comparison of candidates within the list according to various criteria.

- *Negotiation of offers*

  Shopping agents need not be restricted to providing the shopper with information. Ideally shopping agents should negotiate prices and service options with retailers.

- *Product Selection and Purchase*

  Naturally, shopping agents should facilitate the transaction itself.

- *Product Support*

  The shopping agent should be able to be used as a channel through which product service can be delivered.

It is worth emphasizing the potential of such agents to operate as bi-directional channels. That is, not only can they provide information to the shopper, but, at the shopper's discretion, they may provide information to retailers as well. We intend to demonstrate this potential in the next version of SHOPPER'S EYE by having it communicate a shopper's goals and preferences to a retailer-based agent, who, in turn, responds with a customized offer that bundles service along with the product. Enabling the customization of offers is crucial to gaining the cooperation of retailers who are reluctant to

compete solely on price and of value to customers who base their purchases on criteria other than price.

## 4.2 The Current SHOPPER'S EYE Prototype

At the present time we have a working prototype of SHOPPER'S EYE for a Windows CE PDA equipped with a GPS (global positioning system) receiver. This prototype works for the Old Orchard shopping center in Skokie Illinois, an outdoor mall containing approximately 110 stores.

SHOPPER'S EYE uses a GPS receiver to determine the user's location, thereby limiting its use to outdoor malls. The advantage of GPS for SHOPPER'S EYE is that it enables the retrieval of data for nearby stores without relying on the presence of any special equipment at the mall itself. Although the accuracy of smaller, inexpensive receivers is limited to approximately 75-100 feet, this has thus far proven to be all that is necessary to identify accurately the immediately surrounding stores.

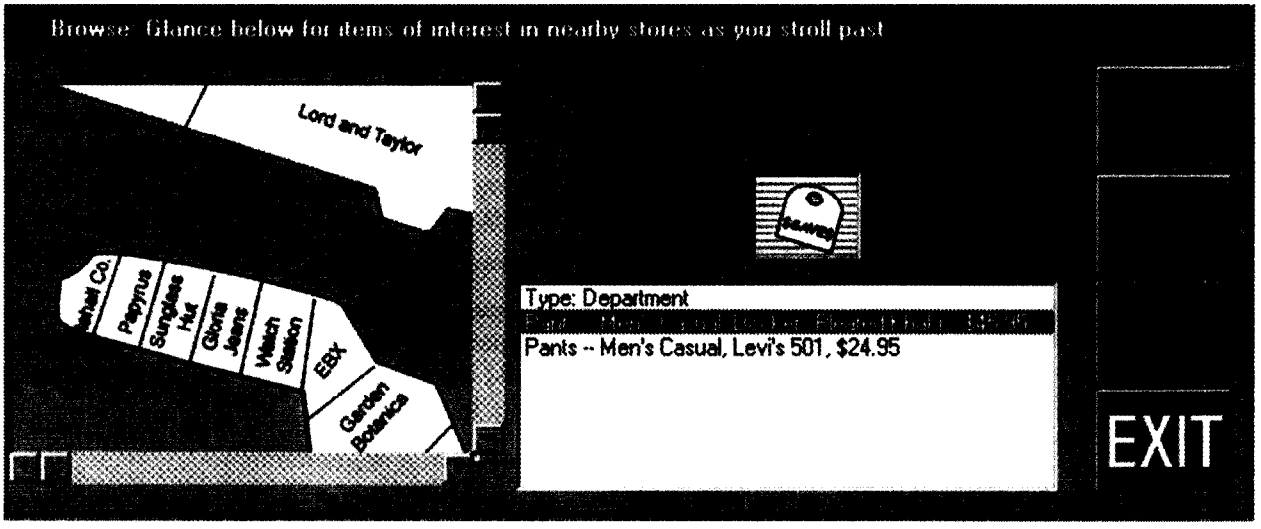


**Figure 1: The SHOPPER'S EYE screen.**

*SHOPPER'S EYE is informing the shopper of items of interest available at Lord and Taylor. The presence of the "save" icon indicates that a cheaper local alternative is available.*

The current SHOPPER'S EYE prototype uses generated data rather than actual store ads and prices. While we acknowledge that gaining access to store merchandise and prices in a manner that can be compared across varying formats is an important issue, it is not the focus of our current work. We are optimistic that this challenge will be addressed in a number of ways. First online catalogs tend to be reasonably well structured. Already some researchers have had success building agents that "learn to shop" at a given store using a relatively small amount of knowledge [4]. Moreover, as retailers begin to use standard packages to create online catalogs, we can expect the number of differing formats to decrease, resulting in a tractable number of competing formats. As electronic commerce progresses, it is not unreasonable to expect standards to evolve governing how merchandise offerings are represented.

The current version of SHOPPER'S EYE is designed for use as follows:

### Goal Specification

Before leaving on a shopping trip, shoppers using SHOPPER'S EYE create a shopping list of items by selecting from a preexisting set of approximately 85 product categories (e.g. men's casual pants, women's formal shoes, flowers, etc,). They also indicate the shopping venue they intend to visit from a list of malls. As mentioned above, only one mall has been included at this time.

### Initial Store Selection

Upon arriving at the mall, SHOPPER'S EYE begins by suggesting the closest store that sells at least one item of a type entered by the user during goal specification. Along with the store name SHOPPER'S EYE lists the specific items available and their prices. A map of the mall displays both the precise location of the store and the shopper's current location. The shopper can ask SHOPPER'S EYE to suggest a store at any time based on their current location.

### Browsing

As noted earlier, 42% of people who visit malls do so

without a particular destination in mind. As shown in Figure 1, SHOPPER'S EYE includes a browse mode for use by shoppers as they stroll through the mall. In browse mode SHOPPER'S EYE suggests items of interest for sale in the stores currently closest to the shopper. An item is considered to be of interest if it matches the categories entered in the goals screen. If there are no items of interest, SHOPPER'S EYE simply states the general type of merchandise sold at that store, rather than specific items. As the shopper strolls a map displays his or her precise current location in the mall.

**Alternatives**

If an item displayed is selected by the shopper while browsing, SHOPPER'S EYE will alert the shopper to the local retailer offering the same product for the lowest price, or announce that it is the best local price. This search is restricted to the local mall, as that is the assumed radius the shopper is willing to travel.

## 4.3 Future Work

As mentioned above, we are currently developing a new version of SHOPPER'S EYE intended to support the broader aspects of the shopping task. We are particularly interested in exploring the possibilities enabled by treating SHOPPER'S EYE as a two way channel between the shoppers and retailers. While this paper has discussed location-based filtering primarily in the context of the shopping task, we are confident this technique can help form the basis for "physical task support" agents that provide an information channel to people engaged in tasks in the physical world.

# 5. ACKNOWLEDGMENTS

Thanks to Nagendra Prasad, Kishore Swaminathan and Joe McCarthy for their helpful comments and discussions on drafts of this paper. Thanks also to Rafael Dowti and Scott Kurth for their programming efforts.

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