Framework of Competitor Analysis by Monitoring Information on the Web

Simon Fong
Department of Computer and Information Science
University of Macau
Taipa, Macau SAR
Email: ccfong@umac.mo

***Abstract*—Competitor Analysis (CA) is an important part of the strategic planning process. By spying every move of the competitors offers a company an advantageous position in decision making. With the advent of World-Wide-Web technology, many businesses extend their activities to the Internet platform, from online marketing to customer services, thereby left over traces of valuable information for competitor analysis. The scattered information can be collected from the Web for studying what the competitors are doing and what products and services they offer up-to-date. In the past CA was conducted manually and it was a tedious process. The sources of such Web information are diversified and the contents are updated frequently too. It is therefore desirable to build an efficient and automated tool that gathers competitor information, monitors the updates and formulates them into useful competitor intelligence with minimum human intervention. Although many information retrieval and monitoring technologies have been developed, they are more for generally tracking changes and downloading the whole websites for offline browsing. In this paper, a framework of automated competitor analysis is proposed as a holistic solution. It is a Web monitoring tool that works for both Web 1.0 and Web 2.0. The designs of the components and the operational challenges are discussed respectively.**

***Index Terms*—competitor analysis; Web information; Information system design**

I. Introduction

World-wide-web (or simply the Web) has grown into a huge virtual world of information by itself, where information are dynamically generated, disseminated, and viewed by millions of users on a global scale. Businesses tapped on the power of the Web for doing online marketing, online customer services and released a significant amount of information about their products, services, promotions and latest news. More and more companies commit to update their websites for showing their latest business information for publicity. At the same time, Web users posted, commented and discussed about the businesses and their products and services online. Out of this tremendous pool of information, some information, either implicit or explicit, which are pertaining to competitors' activities and news, are valuable for doing competitor analysis for a company. From the perspectives of competitor analysis, it is vital for a company to keep informed of what their competitors are doing and what products and services they offer up-to-date; and then absorb feedbacks and opinions from the Web users about their products and services.

By acquiring such information from the Web, the company can gather business intelligence for planning countermeasures and remain competitive. Hence it is crucial for a company to have the right tool to effectively gather such information from the Web. Many information retrieval and monitoring technologies have been proposed in the literature, such as OpenCQ [1], WebCQ [2], CONQUER [3] and Niagara [4]. There are many commercial products too in models of Application Service Provider such as the ones listed in Table 1.

TABLE I. Web Monitoring Systems

Service/Product	URL
WatchThatPage	http://www.watchthatpage.com
Wisdomchange	http://www.wisdomchange.com
ChangeDetection	http://www.changedetection.com
ChangeDetect	http://www.changedetect.com
Track Engine	http://www.trackengine.com
WebsiteWatcher	http://www.aignes.com

They are generally content monitoring services that periodically watch Web pages and other Internet resources for keyword related content or changes. However they are more for generally tracking changes and downloading the whole websites for offline browsing than for tactical CA.

In this research, we focus on Web business environment in which knowing one's competitors is of crucial importance to the survival and growth of any business. Before the Internet became popular, it used to be an expensive process in obtaining business intelligence information quite often from printed publication and other media channels. Although nowadays much of the information is freely available from the Web, they are scattered and dynamic in nature. Like searching for a grain in an ocean, acquiring useful information from the competitors' Web sites as well as from other Web news portals is still a tedious and time-consuming task. Furthermore, many companies nowadays extended their e-business activities to Web 2.0 for example Facebook and Twitter, for engaging customers and extending their marketing platform online. Data from Web 2.0 are known to be scattered, distributed and unstructured in contents; the updates of such data of Web 2.0 are more dynamic than that of page contents in traditional website. Web 2.0 certainly imposed extra challenges for the job of

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competitor analysis, especially in the information retrieval and updates tracking.

Many companies today opt to invest certain resources in collecting information about their competitors from the Web and other channels. It is a regular routine that they keep track of what their competitors are doing, what products and services they offer and any news that concern about them. This is usually done by manual browsing, by the marketing personnel. From our industrial experiences, the approach of acquiring business intelligence from the Web by manual browsing poses a number of problems, such as:

1. Business websites especially that of the large international cooperates often have a large number of pages in the number of hundreds, which makes it very tedious for manual browsing without any automated assistance. The overwhelming amount is a major cause to human errors in selecting the correct information.
2. Different companies may organize the same information very differently, due to differences in culture and practices. One company may use one format and another may follow a different style. The diverse and unstructured formats make manual browsing a daunting.
3. Beyond the competitors' websites, there are certainly other websites, forums, news portals feature news about the competitors and their products. Searching the World-Wide-Web for all possible sites that might have mentions of the competitors is an extremely tedious task if done manually.
4. The speed of updates on some information portal, such as stock market, headline news, news feed from social networks could be beyond that of a human task that consumes time in continuously searching, downloading, extracting, analyzing and archiving. The balance of completeness and timeliness of downloading online information has been discussed in [5]. This implies some automated process must be implemented to capture the right information over the Web at the right time intervals.

The amount of information within a site and new sites is growing at a phenomenal rate. Also for social networks, new user accounts, blogs or groups that are relevant to the CA concerns, emerge very rapidly; their contents are constantly refreshed and are forever growing. Monitoring such information can no longer be easily done manually.

II. Our Proposed Framework

In this paper we propose a competitor analysis framework that is based on the design of an automated market monitoring Web agent system, namely Market Watcher Agent, for gathering business information relevant to a company in an automated approach. The technology is designed to assist competitor analysis that has the following important roles in strategic planning:

- *To help management understand their competitive advantages/disadvantages relative to competitors.*
- *To generate understanding of competitors' past, present (and most importantly) future strategies.*
- *To provide an informed basis to develop strategies to achieve competitive advantage in the future.*
- *To help forecast the returns that may be made from future investments (e.g. how will competitors respond to a new product or pricing strategy?)*

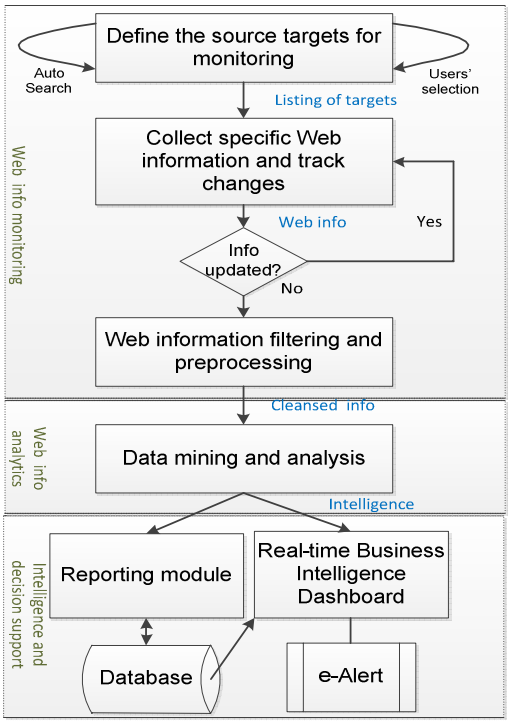

Figure 1. The workflow of the CA framework by monitoring Web info.

The workflow of the CA framework by monitoring Web information is presented in Figure 1. All the steps are supposed to fulfill the roles of CA as an ultimate goal as mentioned above. The workflow can be briefly divided into three phases, namely *Web Information Monitoring*, *Web Information Analytics* and *Intelligence and Decision Support*.

Data mining and decision support techniques are applied that convert collected Web information into meaningful business intelligence. The business intelligences are in turn, presented and used by the management through reporting and dashboard technologies respectively. In real-time, business intelligence of two levels, statistical numeric level and raw messages, and abstract level in which the messages carry semantic meanings can be presented. If needed, users can preset certain rules so that instant alerts can be sent to the managers' mobile phones or PDA for immediate attention.

For example, the decision support module should be able to answer the following questions when undertaking competitor analysis:

- *How did our competitors compete with us?*
- *What threats do they pose?*
- *What are the estimated impacts as a result of their latest competitive move? (forecast and chronicle)*
- *What are the objectives of our competitors? And how far they have achieved or failed them?*
- *What strategies are our competitors pursuing and how successful are these strategies?*
- *What are the strengths and weaknesses of our competitors?*
- *How are our competitors likely to respond to any changes to the way we do business?*

The Market Watcher Agent that is the main power horse in the Web Information Monitoring layer (as in Figure 1) is an autonomous software program that "spies" on the competitors' prices and news information over the Web. The watcher agent consists of mainly two parts, namely, market watcher and price watcher. In this paper, market watcher is described in detail while detailed description on price watcher can be found in [6]. The Market Watcher is an information-collecting tool, which assists the users to monitor the specified Web sites, e.g. competitors' web sites, and to locate the relevant information automatically. The market watcher has two sub-components, namely market monitor and market explorer. The Market Monitor works as an information filter. The objectives of the Market Monitor is to find the news updating on competitors' web sites and to find news articles from some established news portals for particular products, for example, CNN and BBC. The Market Explorer, on the other hand, is an information provider, which is able to get the most updated information worldwide. As the Internet is extremely dynamic, it will never be enough to get news from a fixed number of Web sites, i.e., the competitors' official web sites and certain news portals. With the help from various types of the Internet search engines, worldwide information can be collected by passing users' queries to the search engines and retrieving the top matches. At least two kinds of information can be discovered with the search records from such popular search engines. One is the information about a particular product that cannot be easily found from the competitors' official web sites or news portals: for example, user's feedback or technical web site's product reviews. The other is the product ranking, or how prominent your product can be reached by the Internet users from search engines. For example, if the query "inkjet printer" is given to Google search engine, manufacturers in the top 20 matches will be Epson, Kodak and HP.

In summary, Table 2 lists the information which constitutes to business intelligence, and from where over the Web such information could be obtained.

TABLE II. SUMMARY OF WEB INFORMATION TO BE MONITORED

Where can be found	Web information as business intelligence
Competitors' websites	Competitors price information
	Competitors product information
	Competitors company information
News portals	Product and company news on media
Social networks	Product and company news
	Customers' feedbacks and community impacts
Popular search engines	Product and company news as search results returned from search engine
	Search engine rankings

The rest of the paper is organized as follows. In Section 3, the system architecture is described in detail. Operational processes for market monitor and market explorer are presented in Section 4 and 5 respectively. Section 6 discuses about the performance evaluation. Finally we conclude our work in Section 7.

III. SYSTEM ARCHITECTURE

As shown in Figure 2, in the Information Retrieval Layer, the URL Retrieval Engine takes two parameters as input, the URL and downloading level. The URL Retrieval Engine issues requests to the corresponding Web server and retrieves Web pages. The Web pages are then stored as data files. On the other hand, the matches from the Internet search engines are also retrieved in retrieval layer. The search queries are from the Market Watcher.

The Compilation Layer is the core of the Watcher Agent, which includes the Price Watcher and Market Watcher. The Price Watcher takes the data files and the list of product names. It then detects the matched product names, and extracts price respectively from the Web pages. The Market Watcher is made up of two sub-components, namely, Market Monitor and Market Explorer. The Market Monitor monitors the Web pages for interesting updates and news information as an information filter. The Market Monitor can be set to work repeatedly on either daily or weekly basis. However, there could possibly be overwhelming amount of news on the Web sites. Hence it provides an instant events section. A small module named Instant News Watcher will be designed as a part of the Market Watcher Agent. The Instant News Watcher can monitor the instant news section from few important Web sites on an hourly base or even every few minutes upon scheduled.

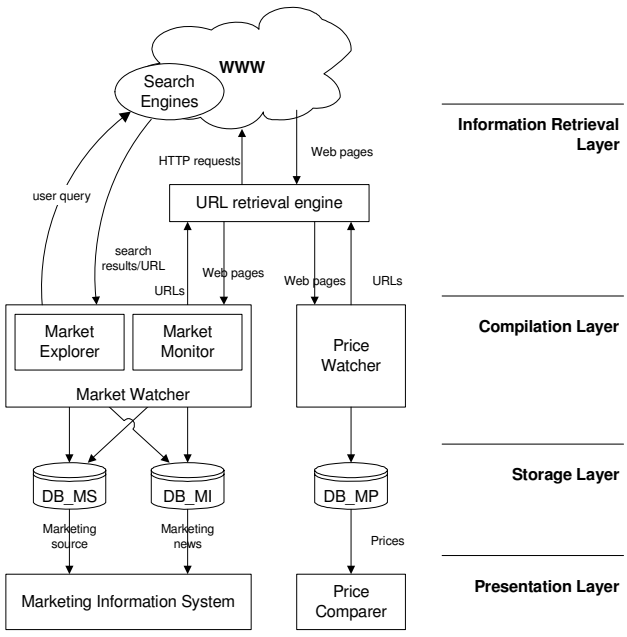

Figure 2. Watcher Agent System Architecture

The Market Explorer is a both retrieval and formatting tool, which passes the user queries to a number of popular search engines available on the Internet and collects the matches from each of the search engines.

The Storage Layer is the local database, which stores price information collected by Price Watcher, the marketing news from Market Watcher, and the searching matches from the Market Explorer.

The Presentation Layer consists of a set of Web pages generated from the local database upon request. Part of the Web interface works for the price comparison of various Web sites on any particular product. For the Market Monitor, a set of market news reports will be generated directly from the database. The instant news report can also be generated upon user's request. The local search engines that directly work on the database are also a part of the presentation layer. These search engines can help user to locate the relevant information from the local database. Since the data is ready to use, local searching will save users' time substantially. For instance, three local search engines can be developed for Market Watcher Database, Price Database, and Market Explorer search history respectively. Search engine for the Market Watcher Database will help user search for the news reports about the query. Search engine for the Price Watcher Database will be able to locate the price of a particular product easily. Users may find relevant information from the search history with the help of a local search engine rather than make a search session over the Internet.

IV. Market Monitor

A. Information Extraction

One important operation of market monitor is to extract information from competitors' web sites. Given a list of pre-defined competitors' web sites, information about new product release or similar in other area should be extracted using a full or semi-automatic HTML wrapper [7]. A HTML wrapper is a kind of software that extracts a certain paragraph or a section from HTML pages based on the HTML tags, formatting or structural information. HTML wrappers normally make use of rule-based leaner or machine learning techniques to learn how to extract the desired information accurately based on the given sample pages. With such a HTML wrapper, market monitor scans the web sites (given by the users) based on the schedule setting and extracts the detailed news information.

B. Information Filtering

Another information resource for the market monitor is from the news portals. Different from the pre-defined the competitor's web sites, majority of the news articles from a new website, say CNN or BBC, are normally not relevant to competitors. Taking an Information filtering approach is necessary to filter out the unrelated information. Filtering is the operational mode in which the queries remain relatively static while new documents come into the system (and leave).

In this filtering task, a user profile describing the user's preferences is constructed. Such a profile is then compared with the incoming documents in an attempt to determine those that might be of interest to this particular user profile. Hence, the filtering approach can be used to select news articles broadcast every day or the newly uploaded Web pages from specific Web sites. One of the difficulties to design such a filtering system is on how to construct the user profile that truly reflects the user's preferences.

Typically, the filtering task simply indicates to the user the documents that might be of interest to him. The task of determining which ones are really relevant is fully reserved to the user. The documents ranking generated by the system may or may not be presented to the user. However an internal ranking is normally computed to determine potential relevancy of documents. For example, the documents with a higher ranking than the predefined threshold may be selected.

C. User's Profile Construction

Two approaches, which are introduced in [8], can be described as words "static" and "dynamic". The static approach is to simply take a set of keywords from user to construct the user's profile. The keywords then can be directly compared with the documents arriving at the system. A similar way is used by a number of Web sites like Hotmail where a set of choices are listed to be selected by users. The choices may be personal interests such as sports news, music, or computer news. The result of the selection will be used to construct a simple user profile. The dynamic approach works exactly the same as the static one in the beginning. A set of keywords is required from user to construct an initial profile. As new documents arrive, the system uses the initial profile to select the documents of potential interest and present to user. The user will then go through the recommended documents, select the relative ones and pass this information back to the system with a feedback process. The system uses this feedback information to adjust the user profile so that it reflects the new preferences just declared. The dynamic approach keeps catching up with the user's feedback and adjusts the profile to be as close to the user's preferences as possible. This is how the dynamic approach will be employed in the Market Watcher Agent.

Since the Market Watcher is designed to be categorization supported, one user profile is constructed for each category. The user profile or category profile in this case, is the keywords given by both the system users. The keywords are called domain keywords for that category.

The dynamic category profile is achieved with a user feedback session. For each Web page recommended by the Market Watcher Agent, there are three choices: worth reading - user agreed with the recommended Web page, no comments - user did not give any choice, and don't waste my time - user disagreed with the recommended Web page, for the user to feedback. Among the total number of users willing to give feedback, the feedback value is derived with the following formula.

$$\text{feedback value} = \frac{\text{User Agreed - User disagreed}}{\text{Total number of user feedback}}$$

The total number of feedbacks received must be greater than the predefined threshold to make the feedback value valid. In case of the feedback value is

high enough (i.e. greater than the threshold), the top matched keyword and the top index term from the Web page will be added to the category profile. The top matched keyword refers to the one from the Web page and has the most number of matches with any of the keywords from user's query. The top index term is the most frequently used index term from the Web page. As a result, the feedback from users is represented by the weight increase of the corresponding index terms in the user query.

D. News article filtering based on document similarity

The input for the Market Watcher is the category profile and a set of Web pages. The output is the information indicating which pages are relevant to the user's requirement. The information is stored in the local database and news report can therefore be generated. The information includes the Web page title, updated time, URL, similarity level, and a summary. The summary will be the first one or two sentences of the page as most of the news writers give a summary in the beginning of the news article. The similarity is calculated with the following formula:

$$Similarity = Query \text{ Vector} \times \text{Document Vector}$$

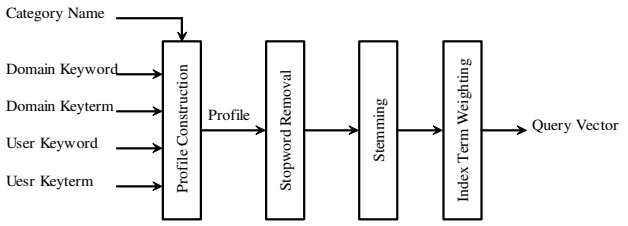

Figure 3. Query Vector Process

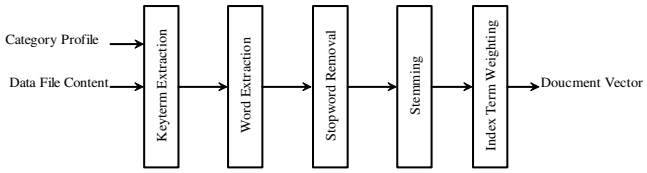

Figure 4. Document Vector Process

E. Instant News Watcher

The Instant News Watcher is developed to retrieve the most updated news from homepages of some Web sites where there are instant event sections. The inputs are category profiles and homepages, and the output will be the updated news extracted.

The Instant News Watcher is a special case of the Market Watcher where more frequent monitoring is required. However, the output is the news instead of the summary of the entire page. The entire structure and most of the contents of the homepage of one Web site will not be updated on daily basis. The frequently updated part is the instant news section or instant event section. Therefore the document-ranking algorithm to calculate the similarity level of the profile and entire Web page cannot be applied to the Instant News Watcher.

In the Instant News Watcher design, the content of the Web page is divided into small sections based on its internal structure with help of the Semi-Data Tree Model that has been used in [9, 10]. Each time, one small section, e.g., one paragraph, one table cell, or one list item, is compared to the category profile. Since the input data is not so much different from the entire Web page, the similarity level given by the document-ranking algorithm will be relative low. For this reason, it's hard to set any default threshold. Therefore, the exact pattern matching is good enough in this case. If one section matches any of the keywords or key-terms from the category profile, the section is considered to be relevant and will then be saved to the database. The duplicated sections will be detected before storing to the database in order to save space.

V. MARKET EXPLORER

Market Explorer is a part of the Market Information System. The objective of the Market Explorer is to assist users to locate the required information with a number of popular search engines available such as AltaVista, Lycos, Excite, Yahoo, Catcha and InforSeek. Other than news from the competitors' official web sites and popular news portals, information about product review or user feedback cannot be easily extracted from the market monitor. With the help of such engines, these kinds of information can be located with the user keywords queries. Similar to market monitor, two functions have been incorporated into the market explorer.

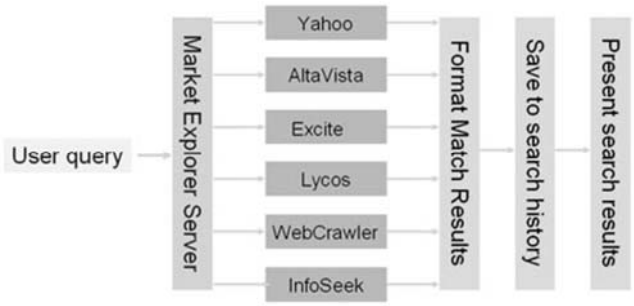

Figure 5. Operational block diagram of Market Explorer

A. Information Extraction

To extract information from the popular search engines, simple keywords queries need to be derived in advance. The keywords can be product names, competitors' names, product brands or a combination of these. From the top matches of the search engines, say top 100, relevant information can be readily extracted. Each record that has been successfully extracted will be associated with a time stamp and stored in the local database for further analysis.

As the matching records from search engines are dynamically generated from databases, the search resultant web pages are normally in the similar format in terms of HTML structures. A HTML wrapper for each search engine is therefore necessary to extract the match records in the search resultant page.

Similar to market monitor, the search queries in market explorer will be relatively static and a scheduled information extraction process needs to be conducted

frequently, say once a day or once a week. Furthermore, a simple local search engine should be developed in order to navigate the extracted information easily as in [11].

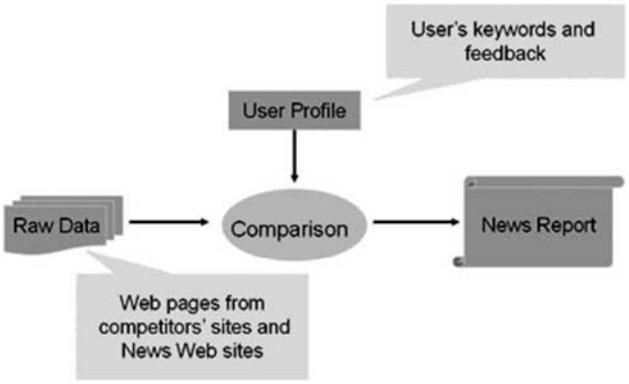

Figure 6. Information filtering process for Market Monitor

B. Product Ranking

With the popularity of the Internet, the World Wide Web has become one of the important information sources for many users. Browsing and search are the two major information access methods. When user wants to find more information about a particular product, a search with the popular search engine is necessary for him/her. Therefore, get to know how easy their products can be accessed from the search engines is important to managers. In market explorer, we have come out with a way of product ranking.

Given a product name, for example inkjet printer, all top N matches from each popular search engine e in the defined search engine list E will be retrieved. For each retrieved match record m, the URL, denoted by $m.url$, the order in the returned search page, $m.o$ can be easily extracted. For any given manufacture's URL, denoted by p.*url*, the rank of the manufacture is defined as:

$$p.rank = \sum_{e \in E} (N - m.o) \text{ where } m.url.domain = p.url.domain$$

With such a rank, how easy the competitor's web pages can be reached from the search engines is clear.

Term Weight $w_{i,j}$ of index term k_i in document d_j

$$w_{i,j} = \frac{freq_{i,j}}{\sqrt{\sum_{i=0}^{t} (freq_{i,j})^2}}$$

Similarity of the document d_j and query q

$$sim(d_j, q) = \sum_{i=0}^{t} w_{i,j} \times w_{i,q}$$

C. Performance Evaluation

he Watcher Agent includes the Price Watcher and the Market Watcher. They can be set to collect price information and the marketing news repeatedly on either daily or weekly basis. Then the results are stored in the local database. Since the data is ready to use, the search engine can get the requested information directly on the local database. Thus it highly increases the performance of search engine and reduces the users' waiting time.

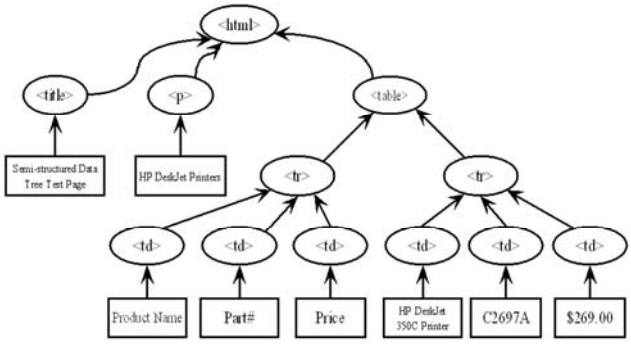

Figure 7. The SDT search steps through HTML files

VI. Conclusion

Many information retrieval and monitoring technologies have been developed. But they are more for generally tracking changes and downloading the whole websites for offline browsing. This paper is to shed some light on specifically the design of a Web monitoring system for gathering business information relevant to a company, especially those related to competitors. For enabling competitor analysis, we proposed an autonomous software agent called Market Watcher that collects competitors' product prices, news, and information on social networks, and monitors their updates on the Web. Market Watcher is built as a market research tool for the users at the back-end. They both run autonomously as to relieve monitoring tasks over websites and search engines otherwise to be tediously carried out by human. The collected intelligence information is usually supplied to marketing managers for business decision making. So far this project has implemented up to the monitoring functions. It is envisaged that Market Watcher can be scaled up to include data-mining functions on competitors' information and automatic reporting as well, in the near future. We are in the progress of integrating Market Watcher into a full business intelligence infrastructure.

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Simon Fong

He graduated from La Trobe University in Australia, with a First Class Honours BEng. Computer Systems degree and a PhD. Computer Science degree in 1993 and 1998 respectively. Simon is now working as an Assistant Professor in the Computer and Information Science Department of the University of Macau. He is also one of the founding members of the Data Analytics and Collaborative Computing Research Group in the Faculty of Science and Technology. Before his academic career, Simon took up various managerial and engineering posts, such as being a systems engineer, IT consultant, integrated network specialist, and e-commerce director in Melbourne, Hong Kong. and Singapore. Some companies that he worked at before include Hong Kong Telecom, Singapore Network Services, AES Pro-Data, and the United Overseas Bank in Singapore. Dr. Fong has published over 150 peer-reviewed international conference and journal papers, mostly in the area of E-Commerce and Datamining.