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(54) **SYSTEM AND METHOD FOR IDENTIFYING CLOAKED WEB SERVERS**

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(58) **Field of Search** 707/4; 709/203, 709/218, 221, 229, 234, 245, 247, 330; 717/170

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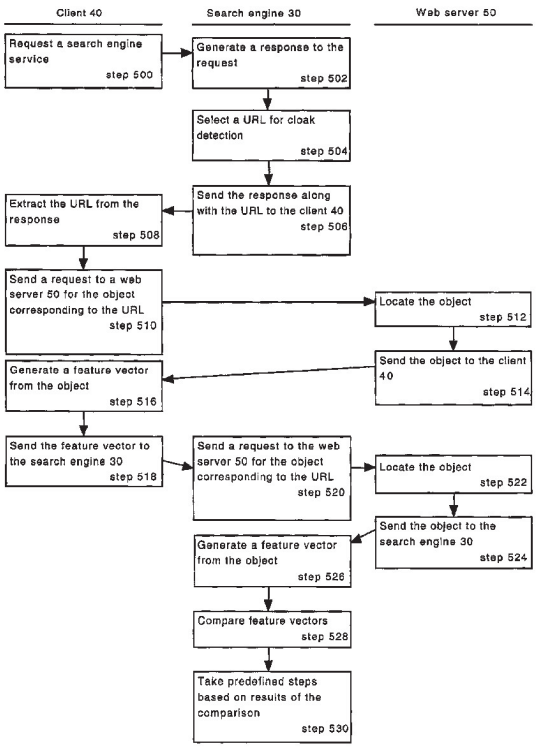
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(57) **ABSTRACT**

A search engine receives from a client a representation of a first object that was returned by a web server to the client in response to a request from the client. The search engine receives from the web server a second object in response to an identical request from the search engine, and compares the representation of the first object to a representation of the second object. The web server is determined to be cloaked if the representation of the first object does not match the representation of the second object. Typically, the client receives a URL embedded in a response to a search request submitted to the search engine. A toolbar operating in conjunction with the web browser on the client processes the URL. The processing includes: directing the web browser to obtain an object corresponding to the URL from a web server addressed by the URL; converting the object to a feature vector; and delivering the feature vector and the URL back to the search engine.

28 Claims, 4 Drawing Sheets



Meta EX1035
Meta v. SitNet
IPR2026-00111

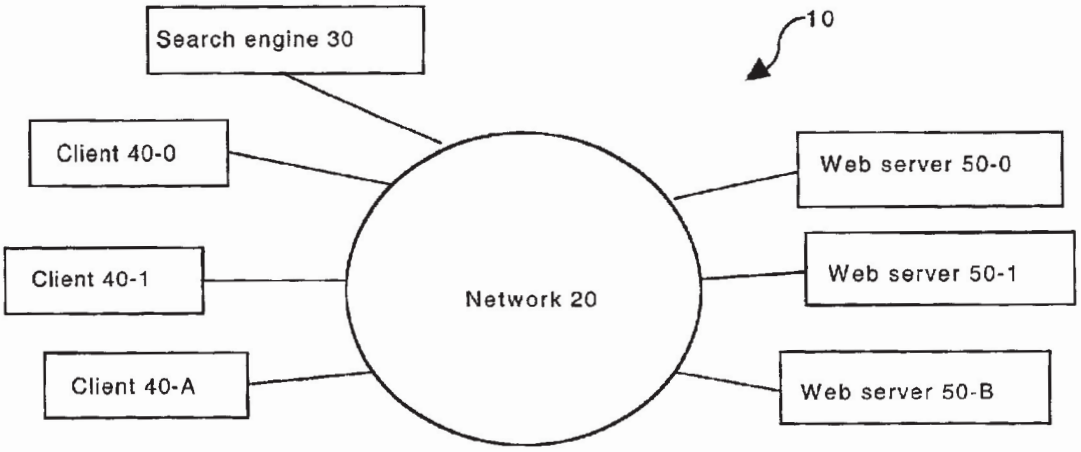


Figure 1

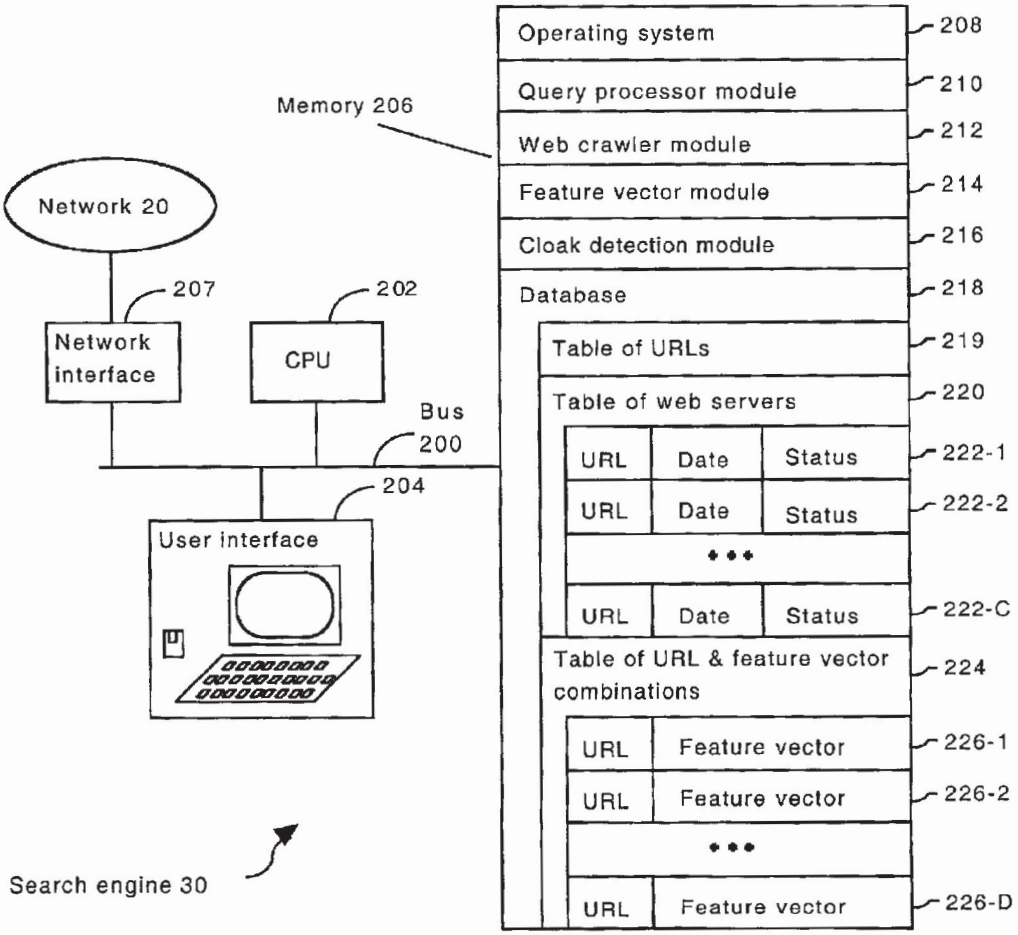


Figure 2

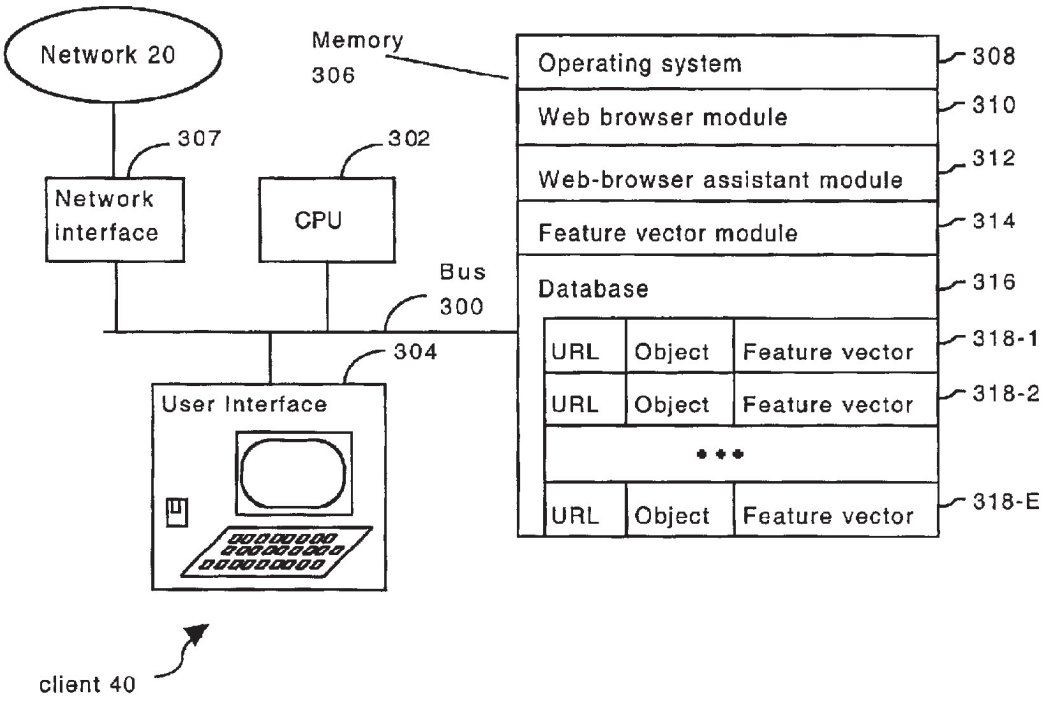


Figure 3

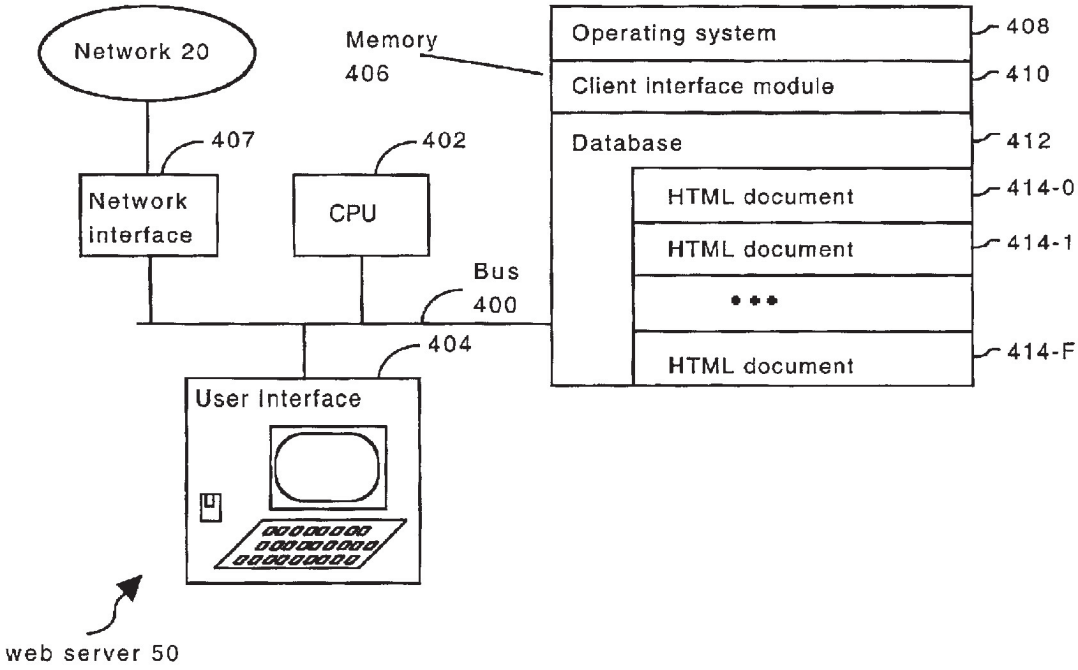


Figure 4

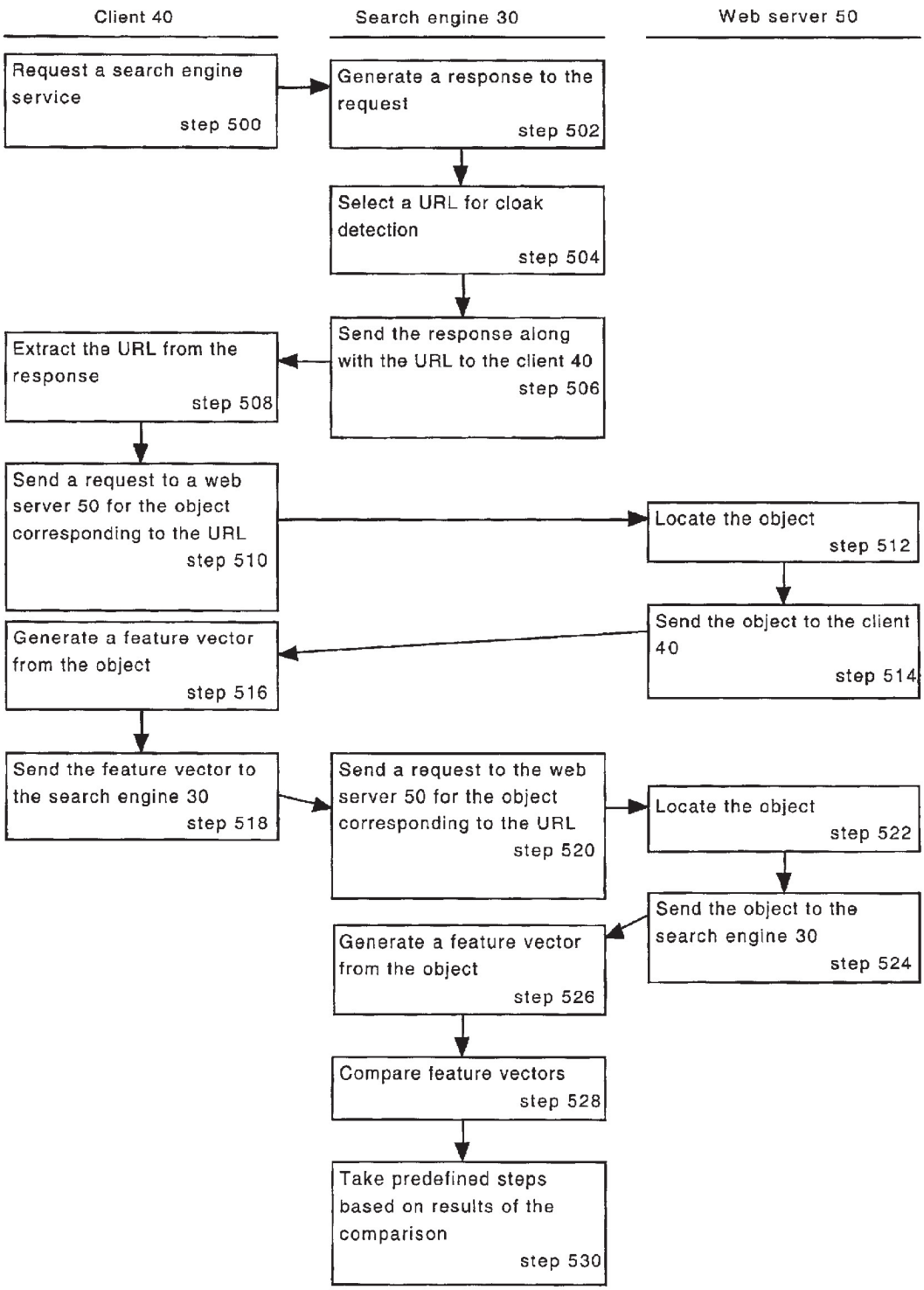

Client 40
Search engine 30
Web server 50
Request a search engine service
step 500
Generate a response to the request
step 502
Select a URL for cloak detection
step 504
Send the response along with the URL to the client 40
step 506
Extract the URL from the response
step 508
Send a request to a web server 50 for the object corresponding to the URL
step 510
Locate the object
step 512
Send the object to the client 40
step 514
Generate a feature vector from the object
step 516
Send the feature vector to the search engine 30
step 518
Send a request to the web server 50 for the object corresponding to the URL
step 520
Locate the object
step 522
Send the object to the search engine 30
step 524
Generate a feature vector from the object
step 526
Compare feature vectors
step 528
Take predefined steps based on results of the comparison
step 530

Figure 5

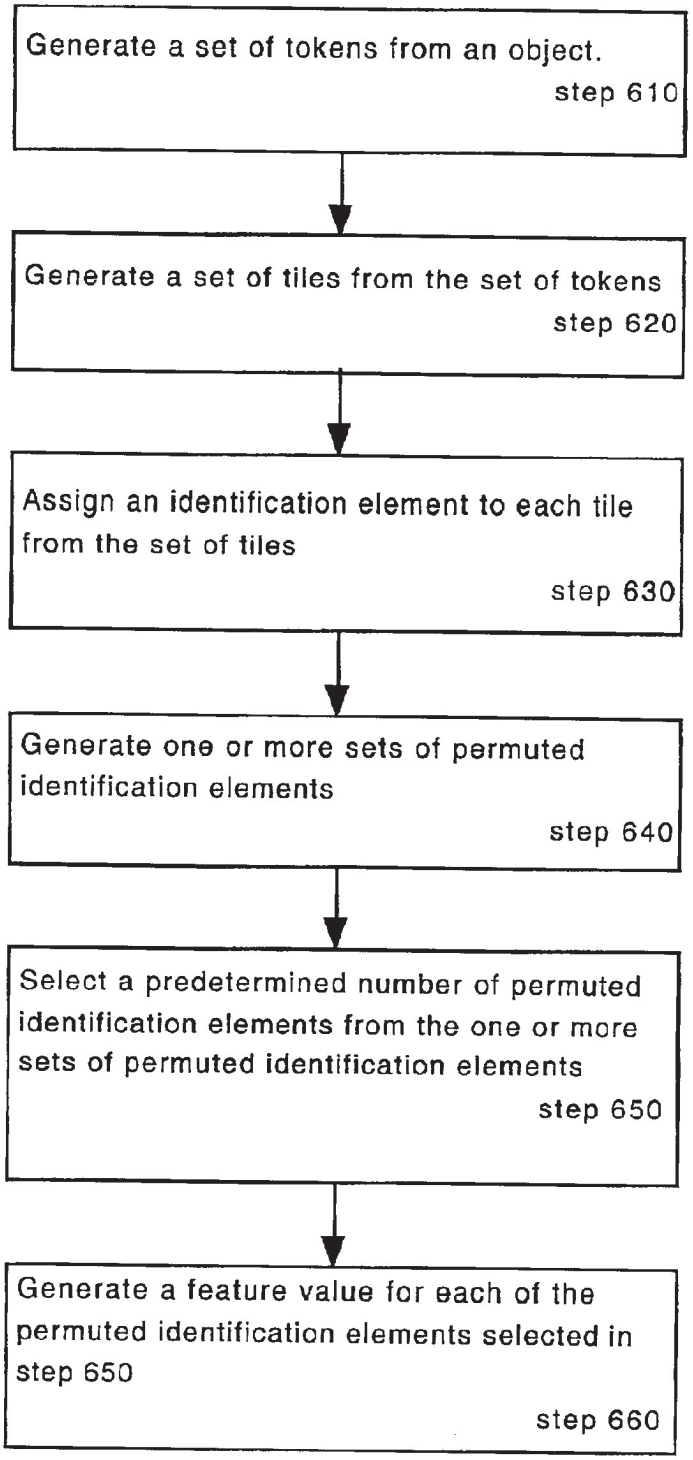

Generate a set of tokens from an object.
step 610
Generate a set of tiles from the set of tokens
step 620
Assign an identification element to each tile from the set of tiles
step 630
Generate one or more sets of permuted identification elements
step 640
Select a predetermined number of permuted identification elements from the one or more sets of permuted identification elements
step 650
Generate a feature value for each of the permuted identification elements selected in step 650
step 660

Figure 6

SYSTEM AND METHOD FOR IDENTIFYING CLOAKED WEB SERVERS

The present invention relates generally to a system and method for detecting cloaked web servers, and more particularly to identifying web servers that provide a first object to a client and a second object to a search engine (i.e., web crawler) in response to an identical request from each.

BACKGROUND OF THE INVENTION

Cloaking is the process by which a web server delivers a first version of an object, such as a web page or HTML document, to a user and a second version of the object to a search engine (or more specifically, a web crawler affiliated with the search engine) in response to essentially identical requests. A web crawler is a process that accesses a plurality of web servers to index the contents of the web servers. More specifically, the web crawler downloads objects from the web servers and stores the objects and their corresponding URLs (i.e., the network addresses of the objects) in a database. A search engine affiliated with the web crawler subsequently accesses the database to select zero or more objects that correspond to a search request received from a client (i.e., a user operating a personal computer).

Web servers are able to identify the program (i.e., a web crawler/search engine or a user's web browser) that emitted a request (e.g., an HTTP request) for a particular object by reference to content of the request. Table 1 illustrates the contents of a typical HTTP request:

TABLE 1

GET /index.html HTTP/1.0
HOST: www.domain_name.com
USER_AGENT: Mozilla/4.71
REFERER: http://search_engine.com

The first line of Table 1 identifies the object sought and the location of the object on a corresponding web server. In this example, the object is an HTML document entitled "index.html" and is located in the root directory. Additionally, the first line includes a protocol identifier. In this example, the protocol is version 1.0 of HTTP, which is used to request and transmit files, especially web pages and web page components, over the Internet or other computer network.

The second line of Table 1 identifies the hostname, which can be translated into an Internet address, of a web server. In this example, the hostname is "www.domain_name.com". The URL corresponding to the object of this request is, therefore, "http://www.domain_name.com/index.html".

The third line of Table 1 is the USER_AGENT field, which identifies the program that emitted the request. In this example, "Mozilla/4.71" and the remaining text identifies the program as a Netscape® web browser. Note that web browsers are typically associated with users, not search engines.

The fourth line of Table 1 identifies the hostname of the entity that referred the requester to the identified web server. In this example, the referrer is a fictional search engine.

With respect to the present invention, line three of Table 1 is the most important. This line can indicate whether the request was sent by a web browser or a web crawler/search engine. More specifically, most web browsers set the USER_AGENT field to a string that is easily recognizable by a web server as corresponding to a web browser, and thus not a search engine/web crawler. Additionally, most web crawlers/search engines have well known names, which are typically included in the USER_AGENT field. For example, a web crawler associated with the search engine Alta Vista® is named "Scooter." A request for an object from this web crawler would, therefore, typically include the string "Scooter" in the USER_AGENT field. This field can, however, be arbitrarily set before being sent by a web browser or a web crawler/search engine to a web server. The USER_AGENT field does not provide, therefore, a foolproof means for identifying the program that emitted the request.

However, an IP-address typically included with a request can also be used to identify the program that emitted the request. Persons skilled in the art recognize that HTTP is a protocol that operates in conjunction with but on a higher level than TCP/IP, which is a packet based protocol, and that an IP-address is a 32-bit number that identifies each sender or receiver of TCP/IP packets. HTTP requests are included in TCP/IP packets, so HTTP requests are accompanied by the IP-address of the requestor.

Importantly, web server operators who engage in cloaking typically have lists of IP-addresses associated with web crawlers/search engines. So when, for example, an HTTP request is received by a web server, the IP-address is checked to determine whether the requester is, or is associated with, a web crawler/search engine. The IP-address of the requestor is thus another means for identifying the program that emitted the request.

Proponents of web cloaking claim a number of benefits from cloaking—including code (i.e., the design of a given object) and copyright protection. The importance of protecting code stems largely from financial gain made possible by a large number of referrals induced by the code.

Whether a search engine refers a given web server to a user (i.e., returns a URL corresponding to the given web server in response to a query from a user) depends upon the relevance of objects available from the web server to a given query. Relevance is, in turn, determined in part by, for example, an analysis of keyword combinations, keyword density, or keyword positioning found in a given object. If a search engine determines that an object is highly relevant to a particular keyword or set of keywords submitted with a query, the object may become desirable to other web server operators, which may copy or emulate the object. In particular, a duplicate of the object can be placed on another web server, which has the effect of devaluing the original object, or the object's keyword combinations, keyword density, and/or keyword positioning can be emulated to achieve the same level of relevance for another object. The comparative relevance of a given object can be determined by conducting searches designed to result in a referral of the object.

There is, however, a darker side to cloaking. Some web server operators seek to deceive search engines, and thus users, in order to increase the number of referrals to their web server. For example, an operator could supply an object that is highly relevant to common searches to search engines, but supply an unrelated page to a user in response to object queries. This action compromises search engine integrity and wastes user time.

There is needed in the art, therefore, a system and method for identifying cloaked web servers.

SUMMARY OF THE INVENTION

In summary, a method of the present invention includes a search engine receiving from a client a representation of a

first object that was returned by a web server to the client in response to a request from the client. The search engine receives from the web server a second object in response to an identical request from the search engine, and then compares the representation of the first object to a representation of the second object. The web server is determined to be a cloaked web server if the representation of the first object does not match (i.e., exactly match or, preferably substantially match) the representation of the second object. The representations of the first object and the second object are preferably feature vectors. In some embodiments, the feature vector of the first object is said to match the feature vector of the second object if at least a predetermined number of features in the two feature vectors are the same.

In one embodiment, the client receives a URL embedded in a response to a search request submitted to the search engine. A toolbar operating in conjunction with the web browser on the client processes the URL. The processing includes directing the web browser to obtain an object corresponding to the URL from a web server addressed by the URL, converting the object to a feature vector, and delivering the feature vector and the URL back to the search engine.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and features of the invention will be more readily apparent from the following detailed description and appended claims when taken in conjunction with the drawings, in which:

FIG. **1** illustrates a system including a network, clients, web servers, and a search engine in accordance with a preferred embodiment of the present invention.

FIG. **2** is a block diagram of a search engine consistent with a preferred embodiment of the present invention.

FIG. **3** is a block diagram of a client consistent with a preferred embodiment of the present invention.

FIG. **4** is a block diagram of a web server consistent with a preferred embodiment of the present invention.

FIG. **5** illustrates steps used to implement a preferred embodiment of the present invention.

FIG. **6** illustrates steps used to generate a feature vector.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, there is shown a diagram of a computer system **10** in which an embodiment of the present invention can be implemented. The computer system **10** includes at least one search engine **30**, a plurality of clients **40** (also herein called client computers), a plurality of web servers **50**, and a communications network **20**. The communications network **20**, which interconnects the search engine **30**, the plurality of clients **40**, and the plurality of web servers **50**, is the Internet or other wide area network (WAN), an intranet, a local area network (LAN), metropolitan area network (MAN), or a combination of such networks.

As indicated in FIG. **2**, the search engine **30** includes standard server components such as one or more processing units **202**, an optional user interface **204** (e.g., keyboard, mouse, and a display), memory **206**, a network interface **207** for coupling the search engine **30** to clients **40** and web servers **50** via communications network **20**, and one or more system buses **200** that interconnect these components. Memory **206**, which typically includes high speed random access memory as well as non-volatile storage such as disk storage, stores an operating system **208**, a query processor module **210**, a web crawler module **212**, a feature vector module **214**, a cloak detection module **216**, and a database **218**.

The operating system **208** includes procedures for handling various basic system services and for performing hardware dependent tasks. Further, the one or more processing units **202** execute the programs (i.e., the query processor module **210**, the web crawler module **212**, the feature vector module **214**, and the cloak detection module **216**) under the control of the operating system **208**, which also provides the programs with access to system resources, such as the memory **206** and user interface **204**.

The query processor module **210** responds to queries from clients **40** for the URLs of documents stored on the web servers **50**. Each query typically includes one or more search terms, and the response to the query includes zero or more (and preferably one or more) network addresses (e.g., URLs) of objects (e.g., documents maintained by one or more of the web servers **50**) corresponding to the one or more search terms. More particularly, the query processor module **210** typically selects zero or more URLs for inclusion in a response to the queries by reference to one or more search terms included in the query and to a table of URLs **219** maintained in a database **218**. The particular methodology used for URL selection is not important to the present invention. Many techniques are known in the art, and all are within the scope of the invention.

The web crawler module **212** obtains objects from the web servers **50** that correspond to URLs included in the table of URLs **219**. More specifically, the web crawler module **212** updates the list of URLs included in the table of URLs **219** periodically by downloading objects from web servers **50** and determining whether the objects have been modified since the last time a particular object was downloaded. If an object has been modified, information in the table of URLs **219** pertaining to the object is updated. The table of URLs **219** is preferably indexed by the words included in the objects corresponding to the URLs stored in the table of URLs **219**.

The web crawler module **212** and query processor module **210** are well known in the art. Except as noted below, with reference to the cloak detection module **216**, these two modules can operate according to any technique without departing from the scope of the present invention. Additionally, the web crawler module **212** and the query processor module **210** can also operate on separate servers.

The feature vector module **214** generates a feature vector for an object. A feature vector is a compressed representation of an object, comprising a plurality of discrete features, and is typically much smaller than the object. In preferred embodiments of the present invention, feature vectors are used to compare objects. The likelihood that a first object closely resembles a second object is very high when a feature vector derived from the first object and a feature vector derived from the second object include at least a predetermined number of features in common. For example, in an embodiment where the feature vector for each object contains eight features, two objects whose feature vectors have at least six features in common are assumed to be very similar. The generation of a feature vector is described in more detail below with reference to FIG. **6**.

The cloak detection module **216** preferably augments the operation of the query processor module **210** and web crawler module **212** as indicated above. In particular, when the query processor module **210** receives a query from a

client **40**, the query processor module **210** notifies the cloak detection module **216**, which responds by selecting, and forwarding to the query processor module **210**, a URL corresponding to a web server **50**. The selected URL returned to the query processor module **210** may be one of the URLs that is responsive to the client query, or it may be a URL that is unrelated to the URLs that are responsive to the client query.

In preferred embodiments, the cloak detection module **216** applies a predefined function to the table of web servers **220** to select a URL. As illustrated in FIG. **1**, the table of web servers **220** preferably includes a plurality of records **222** including fields that store a URL, a date, and a state.

In some embodiments, the URLs include only an access protocol (e.g., http) followed by a hostname (e.g., www.domain_name.com). In these embodiments, therefore, the URLs stored in the table of web servers **220** do not specify a hierarchical description of an object or object location on a web server **50**, which are typically configured to provide a default object when a hierarchical description of an object or object location are not included in an object request.

In other embodiments, however, a hierarchical description of an object or object location on a web server **50** is specified in each entry **222** (i.e., URL) of the table of web servers **220**. In these embodiments, the table of web servers **220** can include a plurality of entries **222** that correspond to a single web server **50**. In still other embodiments of the present invention, the table of web servers **220** may actually resemble, or be included in, the table of URLs **219**.

The date field included with each entry **222** of the table of web servers **220** identifies the last date, if any, on which a web server **50** corresponding to the entry **222** was checked for cloaking. In preferred embodiments of the present invention, the date is a parameter of the function that selects a URL for inclusion with the response generated by the query processor module **210**. Preferably, the odds of a given entry **222** being selected increase as the corresponding date becomes older.

The state field included with each entry **222** of the table of web servers **220** reflects the results of one or more determinations as to whether a corresponding web server **50** is cloaked. In some embodiments, the state is, effectively, either yes or no: "Yes", the corresponding web server **50** was cloaked as of the last test or "No", the corresponding web server **50** was not cloaked as of the last test.

Preferred embodiments of the present invention compare the feature vector of a page retrieved from a specified URL by a client computer **40** with the feature vector of the page retrieved from the same URL by the search engine **30**, and use the results of this comparison to determine whether the web server **50** corresponding to the specified URL is cloaked. As noted above, a feature vector is a representation comprising a plurality of features. If, for example, all of the features included in two feature vectors match, the corresponding objects almost certainly match. And if none of the features included in two feature vectors match, the corresponding objects almost certainly do not match. But if just half of the features included in two feature vectors match, the corresponding objects are likely to be partially similar, but different in many respects. However, the amount of difference between the objects is somewhat indeterminate, although statistically the odds are very high that the two objects are significantly different. Such a situation may call for one or more states and corresponding policies. In some embodiments, therefore, an indefinite response (e.g., only half of the features match) will not change or set the state of a corresponding web server **50**. In such embodiments, a predefined number of determinations that are consistently biased towards cloaked or not cloaked (e.g., most but not all of the features match) are required before a state is changed in the direction of the bias. Additionally, the state field in some embodiments indicates how consistently a corresponding web server **50** is determined to be cloaked or not cloaked. If, for example, a given web server **50** has, over an extended period of time, consistently been determined to be cloaked, the value of additional tests may decline. Similarly, if a given web server **50** has, over an extended period of time, consistently been determined to not be cloaked, the value of additional tests may decline. In such cases, additional testing of such web servers **50** may be delayed in favor of testing other, less stable or unknown, web servers **50**. The state, therefore, preferably reflects these situations so that such web servers **50** are selected less frequently for testing. Additional states and policies for determining whether a web server is cloaked may be apparent to those skilled in the art and systems and methods of implementing these are within the scope of the present invention.

In preferred embodiments of the present invention, feature vector representations of objects are compared to determine if the objects are substantially similar. In some embodiments, the feature vector representation of a first object is said to match the feature vector representation of a second object if at least a predetermined number of features in the two feature vectors are the same.

At some point, a feature vector and a corresponding URL are received from a client **40** in response to the same URL being supplied to the client **40** in a query response. The feature vector from the client **40** (i.e., the client feature vector) is generated by the client **40** from an object corresponding to the URL. The cloak detection module **216** stores the feature vector and the corresponding URL from the client **40** in the table of URL and feature vector combinations **224**. More specifically, the cloak detection module **216** creates a new entry **226** in the table of URL and feature vector combinations **224** and stores the feature vector and the corresponding URL in the new entry **226**.

In preferred embodiments, the cloak detection module **216** subsequently directs the web crawler module **212** to obtain an object corresponding to the URL. In other embodiments, the cloak detection module **216** obtains a copy of the object corresponding to the URL from the table of URLs **219**. In still other embodiments, the cloak detection module **216** obtains the object corresponding to the URL without the assistance of the web crawler module **212**. In these embodiments, the cloak detection module **216** preferably runs on the same machine as the web crawler module **212** or on a machine that is known by web server operators to be associated with the web crawler module **212** (i.e., using an IP-address associated with the web crawler module **212**). Additionally, the USER_AGENT field of requests sent by the cloak detection module **216** is preferably identical to the USER_AGENT field of requests sent by the web crawler module **212**. It is important that a web server **50** receiving a request directly from a cloak detection module **216** is able to determine that the request is associated with the web crawler module **212** (i.e., a web crawler/search engine).

The cloak detection module **216** then directs the feature vector module **214** to create a feature vector (herein called the server feature vector) from the object corresponding to the URL obtained by, or under the direction of, the cloak detection module **216**. In an alternate embodiment, the table of URLs **219** stores a copy of the server feature vector for

the object corresponding to each URL in the table (or for each URL that has been successfully downloaded by the web crawler module **212**) and the cloak detection module **216** obtains the server feature vector for the object corresponding to the URL from the table of URLs **219**, without having to compute the server feature vector. In other words, in this alternate embodiment the web crawler module **212**, or another module of the search engine **30**, uses the feature vector module **214** to process the objects downloaded by the web crawler module and to store the resulting feature vector in the table of URLs **219**.

The cloak detection module **216** then preferably uses the URL as an index into the table of URL and feature vector combinations **224** to extract the corresponding client feature vector and compare the client feature vector to the server feature vector. Depending on the results of the comparison and the state of the URL as defined by an entry **222** in the table of web servers **220**, the state of the URL is updated as described above. The cloak detection module **216** also updates the date field in the table of web servers **220** and removes the entry **226** in the table of URL and feature vector combinations **224**.

In an alternate embodiment, the table of URL and feature vector combinations **224** is not used. Instead, the object corresponding to each URL to be checked by the cloak detection module is downloaded and processed by the search engine to generate a server feature vector prior to sending the URL to a client **40** for downloading. As indicated above, the server feature vector is preferably stored in the table of URLs **219**. When the client feature vector is received back from the client **40**, the cloak detection module compares the client feature vector with the server feature vector for the same URL and then updates a corresponding entry **222** in the table of web servers **220**.

If a given web server **50** is determined to be cloaked, several steps can be taken to address this problem without departing from the scope of the invention. For example, the query processor module **210** can exclude from responses to requests from clients **40** information regarding a cloaked web server **50** or a specific URL corresponding to the web server **50** that would otherwise be included. Additionally, a cloaked web server **50** can be "black-listed" so that it is not queried in the future by the web crawler module **212**, thereby preventing the web crawler module **212** from determining what objects are available on the cloaked web server **50** and whether these objects have been modified. Finally, the query processor module **210** can include a warning with a query response indicating that a given URL corresponds to a cloaked web server **50**.

As indicated in FIG. **3**, the clients **40** preferably include standard computer components such as a central processing unit **302**, a user interface **304** (e.g., keyboard, mouse, and a display), a memory **306**, a network interface **307** for coupling the clients **40** to a search engine **30** and various web servers **50** via communications network **20**, and one or more system buses **300** that interconnect these components. Memory **306**, which typically includes high speed random access memory as well as non-volatile storage such as disk storage, stores an operating system **308**, a web browser module **310**, a web-browser assistant module **312**, a feature vector module **314**, and a database **316**.

The operating system **308** includes procedures for handling various basic system services and for performing hardware dependent tasks. Further, the central processing unit **302** executes the programs (i.e., the web browser module **310**, the web-browser assistant module **312**, and the feature vector module **314**) under the control of the operating system **308**, which also provides the programs with access to system resources, such as the memory **306** and user interface **304**.

The web browser module **310** is used to access objects (e.g., HTML documents, graphics, etc.) available from web servers **50** and the search engine **30** via the communications network **20**. As indicated above, the clients **40** query the search engine **30** for URLs corresponding to one or more web servers **50**. More specifically, the clients **40** typically request a plurality of hyperlinks to objects available from the web servers **50**. The web browser module **310** is typically the means by which these queries are submitted by the clients **40**. Examples of web browsers known in the art include Microsoft® Internet Explorer and Netscape® Navigator. Either of these web browsers are suitable for the present invention.

In the preferred embodiment, the web-browser assistant module **312** comprises a plug-in that works in conjunction with the web browser module **310**. In the preferred embodiment, the web browser module **310** loads the web-browser assistant module **312** each time the web browser module **310** is loaded (i.e., becomes an active, running program on a client **40**). The web-browser assistant module **312** preferably manifests visually as a tool bar that is accessible when operating the web browser module **310**. Users of clients **40** can, furthermore, preferably enter search terms (also herein called keywords) and submit the search terms as a query to the search engine **30** directly from the web-browser assistant module **312**.

In alternate embodiments, the web-browser assistant module **312** is not visible to users of the clients **40**. In these embodiments, users of a client **40** submit queries to search engines **30** from the web browser module **310**. The operation of the web-browser assistant module **312** is, therefore, largely invisible to users of the clients **40** in these embodiments.

As is known in the art, plug-ins and tool bars are able to communicate with, and control, web browsers using an application programming interface ("API") that corresponds to the particular web browser used. In preferred embodiments, the web browser module **310** and the web-browser assistant module **312** interact in this way.

For example, in embodiments of the present invention in which the web browser module **310** comprises Netscape® Navigator, the web-browser assistant module **312** can use what is currently known as the Netscape.Network.1 automation object to access web servers **50** and the search engine **30** using mechanisms of Netscape® Navigator such as the SSL security protocol, proxy support, SOCKS support, cache support, and numerous Internet protocols. In particular, the web-browser assistant module **312** can use the Open ( ) function, which is included in the Netscape.Network.1 automation object, to direct the web browser module **310** to submit a query to the search engine **30** and to download an object corresponding to a URL from a web server **50**. Use of the Netscape.Network.1 automation object does not necessarily result in the display, on user interface **304**, of an object downloaded from a web server **50**.

Similarly, the web-browser assistant module **312** can request notification each time the web-browser module **310** goes through an object transition (e.g., displays or loads a new HTML document). For example, in embodiments of the present invention in which the web browser module **310** comprises Netscape® Navigator, the web-browser assistant module **312** can use what is currently known as dynamic

data exchange ("DDE") to control Netscape® Navigator. In particular, the web-browser assistant module **312** registers with Netscape® Navigator using DDE, which has the effect of opening a communications channel between the web browser module **310** and the web-browser assistant module **312**. The communications channel enables the web-browser assistant module **312** to obtain a copy of each search engine query response received by the web browser module **310** and to determine whether that object contains a request for the web-browser assistant to process a URL selected by the cloak detection module **216**.

As noted above, the query processor module **210** of the search engine **30** includes a URL selected by the cloak detection module **216** with at least a subset of the responses to queries received from at least a subset of the clients **40**. And as also noted above, the responses include a plurality of hyperlinks (i.e., URLs). Both the URL selected by the cloak detection module **216** and the plurality of hyperlinks are preferably delivered to the clients **40** in an HTML document. As is known in the art, HTML documents can include a header, which is demarcated by the tags "<head>" and "</head>" and stores a document title and other, optional elements. Each element of the header is typically demarcated by its own pair of complementary tags, such as <title> and </title>. The contents of the document header are typically not displayed by the web browser module **310**. In some embodiments, therefore, the URL selected by the cloak detection module **216** is preferably inserted into the header of an HTML document comprising a response by the query processor module **210**. For instance, in one embodiment the URL selected by the cloak detection module **216** is stored in an element (also called a field) of the document header demarcated by a pair of complementary tags, such as <cloakchk> and </cloakchk>, which need be recognizable only by the web-browser assistant module **312**. If the web browser module **310**, and other web browsers known in the art, do not recognize a given tag, which is likely in this case, the contents of the tagged element (i.e., the information between the pair of complementary tags) are ignored. An HTML document returned by the query processor module **210** can, therefore, include a URL selected by the cloak detection module **216** without adversely affecting a client **40** regardless of whether the client is configured in accordance with the present invention. Note that additional instructions need not be included with the URL since the tags recognizable only by the web-browser assistant module **312** effectively comprise an instruction to the web-browser assistant module **312** to take action. Nevertheless, additional information such as operating parameters for the feature vector module **314** or notification of software updates can be included along with the URL.

But in some embodiments, a URL selected by the cloak detection module **216** is instead included in the HTTP header of responses to queries received from the clients **40**. Table 2 illustrates the contents of a typical HTTP header modified in accordance with an embodiment of the present invention:

TABLE 2

```
HTTP/1.0 200 OK
Server: Microsoft-IIS/5.0
Date: Tue, 18 Dec 2001 06:31:55 GMT
Content-Length: 10867
Content-Type: text/html
X-Check-For-Cloak: http://www.some-site.com/index.html
```

The first line of Table 2 identifies the protocol used and whether the request was successful from the perspective of the protocol. In this example, the protocol is version 1.0 of HTTP. The second line of Table 2 is an optional aspect of HTTP headers that identifies the web server software run by the search engine **30** that sent the response. The third, fourth, and fifth lines of Table 2 indicate, respectively, the current date and time according to the search engine **30**, the size of the accompanying object in bytes, and the format (i.e., content type) of the accompanying object. The sixth line of Table 2 identifies a URL selected by the cloak detection module **216**. The first five lines of Table 2 are representative of typical HTTP headers. The sixth line is a modification consistent with an embodiment of the present invention.

As noted above, unknown tags are ignored by the web browser module **310** and other web browsers known in the art. The same is true of unknown elements, fields, or lines of an HTTP header. An HTTP header returned by the search engine **30** can, therefore, include a URL selected by the cloak detection module **216** without adversely affecting a client **40** regardless of whether the client is configured in accordance with the present invention. Note that additional instructions need not be included with the URL since an HTTP header element identifier (e.g., "X-Check-For-Cloak") recognizable only by the web-browser assistant module **312** effectively comprises an instruction to the web-browser assistant module **312** to take action. Nevertheless, additional information such as operating parameters for the feature vector module **314** or notification of software updates can be included along with the URL.

Additionally, persons skilled in the art recognize that techniques similar to those described above permit the web-browser assistant module **312** to access the HTTP header to obtain information germane to the present invention.

The feature vector module **314** generates a feature vector from an object. As noted above, a feature vector is a representation of an object that comprises a plurality of discrete features and is typically much smaller than the object. Typically, the web-browser assistant module **312** directs the feature vector module **314** to create a feature vector from an object that corresponds to the URL selected by the cloak detection module **216**.

The database **316**, which comprises a cache of documents downloaded by the web browser module, preferably includes entries **318** for each URL selected by the cloak detection module **216** and received by a particular client **40**. Initially, an entry **318** includes only the URL. But after the web-browser assistant module **312** receives the object corresponding to the URL, the entry **318** is updated to include the object. Furthermore, the entry **318** may also be subsequently updated to include a feature vector created by the feature vector module **314** from the object. In some embodiments, an identifier of the search engine **30** is included in the database **316** for use when the web browser module **310** delivers the URL and the feature vector to the search engine **30**.

As indicated in FIG. **4**, a typical web server **50** preferably includes standard computer components such as one or more central processing units **402**, an optional user interface **404** (e.g., keyboard, mouse, and a display), a memory **406**, a network interface **407** for coupling the web server **50** to a client **40** and a search engine **30** via communications network **20**, and a bus **400** that interconnects these components. Memory **406**, which typically includes high speed random access memory as well as non-volatile storage such as disk storage, stores an operating system **408**, a client interface module **410** (sometimes called a protocol engine), and a database **412** of documents.

The operating system **408** includes procedures for handling various basic system services and for performing hardware dependent tasks. Further, the central processing unit **402** executes the programs (i.e., the client interface module **410**) under the control of the operating system **408**, which also provides the programs with access to system resources, such as the memory **406** and user interface **404**.

The client interface module **410** (e.g., Apache and Microsoft® Internet Information Server (IIS)) preferably serves static content (e.g., HTML documents and images) or dynamic content (e.g., content generated using the Common Gateway Interface standard) to a web browser module **310** operating on a client **40** or a web crawler module **212** operating on a search engine **30** via communications network **20** using well known principles.

Further, the client interface module **410** may store static content in the database **412** illustrated in FIG. **4**. The database **412** typically includes an entry **414** for each object stored in the database **412**. In other embodiments, the client interface module **410** stores the static content in a directory system instead of, or in addition to, the database **412**.

Turning now to FIG. **5**, there are illustrated steps used to implement a preferred embodiment of the present invention. In a first step, a client **40** issues a request for a search engine service (step **500**). As indicated above, this typically includes a user of the client **40** entering one or more search terms into the web-browser assistant module **312**. The web-browser assistant module **312** then directs the web browser module **310** to send an HTTP message including the search terms to the search engine **30**. To send the HTTP message, the web-browser assistant module **312** takes advantage of the networking capabilities of the web browser module **310**. At this point, the web-browser assistant module **312** need not take any particular action in anticipation of, or in preparation for, processing a URL selected by the cloak detection module **216**. Instead, the web-browser assistant module **312** preferably waits for notification from the web browser module **310** each time the web browser module **310** loads an object.

Once the request is received by the search engine **30**, the query processor module **210** generates a response using techniques known in the art (step **502**). Briefly, the query processor module **210** scans the table of URLs **219** for zero or more URLs that best match the query. The best matching URLs, if any, are preferably assembled in an HTML document.

Additionally, the query processor module **210** solicits a URL from the cloak detection module **216** upon receiving the query from the client **40**. In response, the cloak detection module **216** selects a URL from the table of web servers **220** (step **504**). The particular function used to select the URL is not critical to the present invention. But the table of web servers **220** preferably includes information such as the date on which the corresponding web server **50** was last selected and the current state of the corresponding web server **50** in the selection process. For example, the cloak detection module **216** in some embodiments of the invention selects the URL with the oldest date, i.e., the longest amount of time since the last test. In another embodiment, the cloak detection module **216** selects one of the URLs in the response to the query if any of the URLs in the response correspond to a web server whose cloak status needs to be checked, and otherwise selects a URL from the URLs stored in the table of web servers **220**. In still another embodiment, the URLs in the table of web servers **220** are selected sequentially, in round robin fashion. In yet another embodiment, the cloak detection module **216** maintains a list of URLs previously selected from the table of web servers **220**, but for which no response has been obtained from the client computer to which the URL was sent. URLs in this list that were last sent to a client computer more than a predefined amount of time ago (e.g., one minute) are re-selected by the cloak detection module **216**.

After selecting a URL, the cloak detection module **216** forwards the URL to the query processor module **210**, which inserts the URL into its query response and sends the response to the client **40** from which the query originated (step **506**).

Upon receiving the response at the client **40**, the web browser module **310** preferably loads the HTML document included therein. The web browser module **310** also notifies the web-browser assistant module **312**, which scans the HTML document, or alternatively the accompanying HTTP header, to extract the URL selected by the cloak detection module **216** (step **508**) and preferably stores the URL in a new entry **318** in the database **316**.

The web-browser assistant module **312** then directs the web browser module **310** to download an object corresponding to the URL selected by the cloak detection module **216** from the web server **50** identified by a hostname included with the URL (step **510**).

After directing the web browser module **310** to download the object, the web-browser assistant module **312** typically requests status updates from the web browser module **310** to determine when the object is available to the web-browser assistant module **312**. But in some embodiments, the web browser module **310** notifies the web-browser assistant module **312** when the object is available to the web-browser assistant module **312**, so no action need be taken by the web-browser assistant module **312** with respect to this object until such notification is received.

Upon receiving the object request (e.g., HTTP request for an HTML document) at the web server **50**, the client interface module **410** creates the object dynamically or locates the object in an entry **414** of the database **412** or on the disk storage of the memory **406** (step **512**). After locating or creating the object, the client interface module **410** sends the object to the client **40** (step **514**). As noted above, aside from engaging in cloaking, the operation of the web server **50** is not critical to the present invention.

Once the object is available to the web-browser assistant module **312**, the web-browser assistant module **312** stores the object in a corresponding entry **318** of the database **316**. The web-browser assistant module **312** then directs the feature vector module **314** to generate a feature vector from the object (step **516**).

FIG. **6** illustrates the operation of the feature vector module **314** (and **214**) in more detail. First, a set of canonicalization rules are applied to the object to generate a set of tokens (step **610**), wherein each token represents an aspect of the object (e.g., a word). One canonicalization rule, for example, includes expanding the object to include common variations of one or more of the tokens. A set of tiles are then generated from the set of tokens (step **620**), wherein each tile comprises a sequence of two or more of the tokens that form the set of tokens. Next, the feature vector module **314** assigns an identification element to each tile in the set of tiles to create a set of identification elements (step **630**). An identification element is typically a short tag for a larger or relatively large item such as a tile. In a preferred embodiment, the identification elements are generated in step **630** by applying a hash function or fingerprint function to each tile in the set of tiles generated in step **620**.

The feature vector module **314** then creates a set of permuted identification elements (step **640**). Each set pref-

erably consists of a permuted version of each of the identification elements assigned in step **630**. Further, each permuted identification element in a given set of permuted identification elements is the result of a common permutation process. Further, a different permutation process is preferably used for each of the sets of permuted identification elements. The feature vector module **314** then selects a predetermined number of permuted identification elements, which the feature vector module **314** partitions into a plurality of groups (step **650**). The selected permuted identification elements are selected using a selection function. In some embodiments the selection function selects the identification elements with the lowest or highest value in each set of permuted identification elements. Other selection functions can be used without departing from the scope of the present invention.

Finally, the feature vector module **314** produces a feature value from each of the plurality of groups (step **660**). Each feature value is the result of applying a function (e.g., a hash function or a fingerprint function) to a corresponding group of permuted identification elements. The set of resulting feature values comprises the feature vector for the object. The result of this process is a representation (i.e., a feature vector) that is both accurate with respect to determining whether two objects match (i.e., exactly match or, preferably, substantially match) and compact in comparison to the object from which it is derived.

Methods for generating feature vectors for specified documents are disclosed in U.S. Pat. No. 6,119,124 entitled "Method For Clustering Closely Resembling Data Objects" and U.S. Pat. Nos. 5,909,677 and 6,230,155 both entitled "Method For Determining The Resemblance Of Documents". Each of these patents is incorporated herein by reference as background information.

The feature vector comprises a plurality of feature values, and is preferably stored in a corresponding entry **318** of the database **316**, which now includes the URL selected by the cloak detection module **216**, an object corresponding to the URL, and a feature vector generated from the object. Referring once again to FIG. **5**, the web-browser assistant module **312** directs the web browser module **310** to send the URL and the feature vector to the search engine **30** (step **518**).

Upon receiving the URL and the feature vector at the search engine **30**, the cloak detection module **216** directs the web crawler module **216** to request the object corresponding to the URL received from the client **40** from the web server **50** identified by the URL (step **520**). In a preferred embodiment, the cloak detection module **216** stores the URL and feature vector received from the client **40** in an entry **226** of the table of URL and feature vector combinations **224** for subsequent processing.

Upon receiving the object request at the web server **50**, the client interface module either creates the object dynamically or locates the object in an entry **414** of the database **412** or on the disk storage of the memory **406** (step **522**). If the web server **50** is cloaked, the client interface module **410** will probably detect that the request originated from a search engine **30** and create or locate an object specifically for that search engine **30**. After locating or creating the object, the client interface module **410** sends the object to the search engine **30** (step **524**).

Once the object is received from the web server **50** at the search engine **30**, the cloak detection module **216** directs the feature vector module **214** to create a feature vector (i.e., the server feature vector) from the object (step **526**), which preferably operates as described above with reference to FIG. **6**. The cloak detection module **216** then compares the two feature vectors—one created by the client **40** and the other created by the search engine **30** (step **528**).

As described above, in an alternate embodiment, steps **520**, **522**, **524**, **526** for downloading the object at the specified URL and generating a server feature vector for the object are performed prior to sending the specified URL to a client (at step **506**) for downloading.

As stated above, a feature vector comprises a plurality of feature values. The likelihood that a first object closely resembles (i.e., is substantially similar to) a second object is very high when a feature vector of the first object shares at least a predetermined number of features with a feature vector of the second object. If the first object closely resembles (or is substantially similar to) the second object (i.e., at least the predetermined number of features match), then it is unlikely that the web server **50** is cloaked. An exact match is not required because objects (i.e., web pages) may change in minor ways from time to time due to advertising content and other non-substantive changes. A web page at the specified URL may also vary slightly from one download to the next because it contains dynamically generated contact, such as the date and time of day, or the name of a user associated with the requesting computer. Additionally, a feature vector is only a representation and does not capture all of the features of a given object. It is therefore possible (but very unlikely), that non-matching objects may produce identical feature vectors. In addition, it is possible (but once again unlikely) that two objects that are different but substantially similar in all important respects may have feature vectors that do not have at least the predetermined number of features in common.

Depending on the result of the comparison, the cloak detection module **216** takes one or more predetermined steps (step **530**). For example, the cloak detection module **216** preferably updates the state of the URL in the table of web servers **220**. Additionally, if the web server **50** is cloaked, the cloak detection module can modify the table of URLs **219** so that the query processor module **210** does not include URLs corresponding to this web server **50** in query responses until after subsequent testing indicates that the web server **50** is no longer cloaked.

The present invention can be implemented as a computer program product that includes a computer program mechanism embedded in a computer readable storage medium. For instance, the computer program product could contain the program modules shown in FIG. **2** or FIG. **3** or both. These program modules may be stored on a CD-ROM, magnetic disk storage product, or any other computer readable data or program storage product. The program modules may also be distributed electronically, via the Internet or otherwise, by transmission of a computer data signal (in which the program modules are embedded) on a carrier wave.

While the present invention has been described with reference to a few specific embodiments, the description is illustrative of the invention and is not to be construed as limiting the invention. Various modifications may occur to those skilled in the art without departing from the scope of the invention as defined by the appended claims.

For example, in alternate embodiments, the web-browser assistant module **312** operates independently of the web browser module **310**. In these embodiments, the web-browser assistant module **312** includes functionality typically found in web browser, i.e., the ability to interact with web servers **50** and search engines **30** to send and receive objects.

In other embodiments, the web-browser assistant module **312** is not passive as described above. In these

embodiments, the web-browser assistant module **312** requests the selection of a URL by the cloak detection module **216** periodically or according to some other schedule.

In still other embodiments, the cloak detection module **216** does not wait for requests for search engine **30** services to select a URL for cloak detection. Instead, the cloak detection module **216** selects such URLs on an on-going basis. The selected URLs are subsequently distributed to one or more clients **40** that are configured to receive unsolicited URLs from the cloak detection module **216** and that are known to the cloak detection module **216**.

In some embodiments, the web-browser assistant module **312** monitors the web browser module **310** to determine whether a user operating the client **40** selects one of the URLs selected by the query processor module **210**. If so, the web-browser assistant module **312** generates a feature vector from the object corresponding to the selected URL, and sends the selected URL and corresponding feature vector to the search engine **30**. In these embodiments, therefore, network resource requirements of the present invention are reduced. And in some of these embodiments, the cloak detection module **216** selects a URL from among the zero or more URLs selected by the query processor module **210**. So if a user operating the client **40** does not select one of the URLs selected by the query processor module **210**, the web-browser assistant module **312** will instead process the URL selected by the cloak detection module **216**.

Finally, some embodiments are designed for systems that have relatively large amounts of bandwidth available for use by the present invention. In these systems, feature vectors, which as noted above are compressed representations of objects, are not used. Instead, the client **40** forwards the object, a portion of the object, or an object representation dissimilar to the feature vector described above, to the search engine **30**. Like the client **40**, the search engine **30** does not use feature vectors and compares objects, portions of objects, or object representations dissimilar to the feature vector described above to determine whether the objects match.

What is claimed is:

1. A method for identifying a cloaked web server comprising:

receiving from a client computer a representation of a first object, said first object returned by a web server to said client computer in response to a first request from said client computer for an object corresponding to a network address, said web server addressed by said network address;

receiving from the web server a second object in response to a second request for the object corresponding to said network address; and

comparing the representation of the first object to a representation of the second object, and determining that the web server is cloaked if said representation of the first object does not match said representation of the second object.

2. The method of claim **1**, further comprising

sending to the client computer the network address prior to receiving from the client computer the representation of the first object.

3. The method of claim **2**, further comprising

selecting the network address from a set of network addresses according to a predefined function.

4. The method of claim **2**, further comprising

periodically sending one of a set of network addresses to the client computer according to a predefined schedule, the network address being selected from said set of network addresses.

5. The method of claim **2**, further comprising

receiving from the client computer a request for the network address prior to sending the network address to the client computer.

6. The method of claim **2**, further comprising

receiving from the client computer a request for search engine services prior to sending the network address to the client computer; and

sending to the client computer a response to the request for the search engine services, said response to the request for the search engine services including the network address.

7. The method of claim **6**, wherein

the request for search engine services includes one or more search terms; and

the response to the request for search engine services includes one or more network addresses corresponding to the one or more search terms.

8. The method of claim **7**, wherein

the network address corresponds to the one or more search terms.

9. The method of claim **7**, further comprising

when the web server is determined to be cloaked, excluding from the response to the request network addresses addressing the web server.

10. The method of claim **6**, wherein

the response to the request for search engine services includes an instruction directing the client computer to return the representation of the first object.

11. The method of claim **1**, wherein

the representation of the first object is a first feature vector comprising a first set of features;

the representation of the second object is a second feature vector comprising a second set of features; and

the comparing and determining including determining whether the second feature vector has at least a predetermined number of features in common with the first feature vector.

12. The method of claim **1**, further comprising

maintaining a list of network addresses corresponding to a search term, said list of network addresses including the network address; and

removing from the list of network addresses the network address if the representation of the first object does not match the representation of the second object.

13. The method of claim **1**, further comprising

maintaining a list of cloaked web servers; and

adding to the list of cloaked web servers the web server if the representation of the first object does not match the representation of the second object.

14. A computer system for identifying a cloaked web server comprising:

a central processing unit, an instruction module, and a network interface;

the instruction module being executable by the central processing unit and including

client interface instructions for receiving from a client computer through the network interface a representation of a first object, said first object returned by a web server to said client computer in response to a first request from said client computer for an object corresponding to a network address, said web server addressed by said network address;

web server interface instructions for receiving through the network interface a second object returned by the web server in response to a second request from the computer system for the object corresponding to the network address; and

compare instructions for comparing the representation of the first object to a representation of the second object and for determining that the web server is cloaked if said representation of the first object does not match said representation of the second object.

15. The computer system of claim **14**, the instruction module further comprising

additional client interface instructions for sending the network address to the client computer prior to receiving the representation of the first object from said client computer.

16. The computer system of claim **15**, the instruction module further comprising

instructions for selecting the network address from a set of network addresses according to a predefined function.

17. The computer system of claim **16**, the instruction module further comprising

instructions for periodically sending one of a set of network addresses to the client computer according to a predefined schedule, the network address being selected from said set of network addresses.

18. The computer system of claim **15**, the instruction module further comprising

instructions for receiving from the client computer a request for the network address prior to sending the network address to the client computer.

19. The computer system of claim **15**, the instruction module further comprising

instructions for receiving from the client computer a request for search engine services prior to sending the network address to the client computer; and

instructions for sending to the client computer a response to the request for the search engine services, said response to the request for the search engine services including the network address.

20. The computer system of claim **19**, wherein

the computer system comprises a web server configured to provide search engine services to one or more client computers.

21. The computer system of claim **19**, wherein

the request for search engine services includes one or more search terms; and

the response to the request for search engine services includes one or more network addresses corresponding to the one or more search terms.

22. The computer system of claim **21**, wherein

the network address corresponds to the one or more search terms.

23. The computer system of claim **19**, wherein

the response to the request for search engine services includes an instruction directing the client computer to return the representation of the first object.

24. The computer system of claim **19**, the instruction module further comprising

instructions for deriving the representation of the second object;

wherein

the representation of the first object is a first feature vector comprising a first set of features;

the representation of the second object is a second feature vector comprising a second set of features; and

the compare instructions include instructions for determining whether the second feature vector has at least a predetermined number of features in common with the first feature vector.

25. The computer system of claim **19**, the instruction module further comprising

instructions for maintaining a list of network addresses corresponding to a search term, said list of network addresses including the network address; and

instructions for removing from the list of network addresses the network address if the representation of the first object does not match the representation of the second object.

26. The computer system of claim **14**, the instruction module further comprising

instructions for maintaining a list of network addresses corresponding to a search term; and

instructions for removing from the list of network addresses each network address corresponding to the web server if said web server is cloaked.

27. The computer system of claim **14**, the instruction module further comprising

instructions for maintaining a list of cloaked web servers; and

instructions for adding to the list of cloaked web servers the web server if said web server is determined to be cloaked.

28. A computer program product for use in conjunction with a computer system, the computer program product comprising a computer readable storage medium and a computer program mechanism embedded therein, the computer program mechanism comprising:

client interface instructions for receiving from a client computer a representation of a first object, said first object returned by a web server to said client computer in response to a first request from said client computer for an object corresponding to a network address, said web server addressed by said network address;

web server interface instructions for receiving a second object returned by the web server in response to a second request from said computer system for the object corresponding to said network address; and

compare instructions for comparing the representation of the first object to a representation of the second object to determine if the representation of the first object matches the representation of the second object; and

cloak determination instructions for determining that the web server is cloaked if said representation of the first object does not match said representation of the second object.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

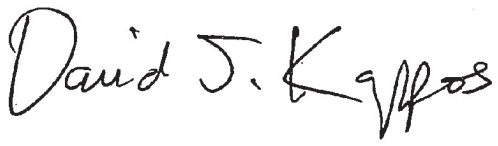
PATENT NO. : 6,910,077 B2
APPLICATION NO. : 10/039603
DATED : June 21, 2005
INVENTOR(S) : Marc A. Najork et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In column 17, lines 57-60, in Claim 23, delete "The computer system of claim 19, wherein the response to the request for search engine services includes an instruction directing the client computer to return the representation of the first object." and insert -- The computer system of claim 21, the instruction module further comprising instructions for excluding from the response to the request network addresses addressing the web server when the web server is determined to be cloaked. --, therefor.

Signed and Sealed this

Eighteenth Day of August, 2009



David J. Kappos
Director of the United States Patent and Trademark Office