

We Claim:

1. A server for identifying and transmitting to a mobile device additional information relating to a query image obtained by a user with a mobile device, the server comprising:

a reference image database storing one or more reference feature descriptors associated with one or more reference images, wherein at least one reference image feature is mapped to a plurality of addresses in the reference image database using a plurality of functions; and

a processor for executing one or more modules comprising:

a query receiving module for receiving, from the mobile device, a first query including one or more query image feature descriptors;

a candidate feature descriptors retrieval module for:

calculating, for each of the one or more query image feature descriptors, a plurality of addresses using the plurality of functions, and

for each of the plurality of addresses, calculating a number of duplicate reference image feature descriptors stored within a pre-defined region of the reference image database;

a candidate images retrieval module for:

selecting a set of reference image feature descriptors based on the calculated number of duplicate reference image feature descriptors;

an image matching module for:

comparing the selected set of reference image feature descriptors with the one or more query image feature descriptors to determine if any reference image matches the query image;

the server further configured to perform the steps of
if a matching reference image is determined, obtaining additional information associated with the at least one matching reference image from an annotation database, and

transmitting the additional information to the mobile device for displaying as additional information relating to the at least one item of interest to the user.

2. The server of claim 1, wherein the processor is further configured to execute a hash table management module.
3. The server of claim 2, wherein the hash table management module further comprises a collision resolving module, for handling hash collisions; and an overflow handling module for handling the association of a new data point (e.g., a set of feature descriptors) with an address in a hash table.
4. A computer-implemented method for identifying and displaying additional information relating to a first query image obtained by a user with a mobile device, the method comprising:

receiving, from the mobile device, a first query including one or more query image feature descriptors corresponding to at least one item of interest to the user included in the first query image;

responsive to receiving the first query, performing a similarity search, wherein the similarity search comprises:

for each of the query image feature descriptors, calculating a plurality of addresses using a plurality of functions;

for each of the plurality of addresses, calculating a number of duplicate reference image feature descriptors stored within a certain region of a database, and wherein at least one reference image feature is mapped to a plurality of addresses in the reference image database using the plurality of functions; and

determining one or more candidate images based on the number of duplicate reference image feature descriptors within the certain region of the reference image database associated with each of the plurality of addresses, the reference image database storing one or more reference image feature descriptors, each of the reference image feature descriptors associated with at least one reference image

comparing the feature descriptors for the one or more candidate images to the query image feature descriptors to determine if there is a match; and

if there is a match, acquiring additional information associated with the match; and

transmitting, to the mobile device, the additional information associated with the match for displaying to the user.

5. The computer-implemented method of claim 4,

wherein the number of duplicate reference image feature descriptors within a pre-defined region associated with an address reflects a degree of similarity between the duplicate reference image feature descriptors and the first query image feature descriptors mapped to the address;

and wherein the determination of one or more candidate images comprises:

determining that the number of duplicate reference image feature descriptors exceeds a pre-determined threshold; and
acquiring the one or more candidate images associated with the duplicate reference image feature descriptors.

6. The computer-implemented method of claim 5, further comprising:

receiving, from the mobile device, a second query including one or more second query image feature descriptors;

comparing the one or more first query image feature descriptors with the one or more second query image feature descriptors; and

based on a result of the comparison:

determining not to perform the similarity search; and

acquiring, based on a mapping between the first query and the one or more candidate images stored in a query cache, the one or more candidate images;

7. The method of claim 4, wherein

wherein reference image feature descriptors are stored within a database based on a hash table including a plurality of buckets, each bucket being associated with an address;

wherein the hash table is associated with a family of hash functions, the family of hash functions mapping one feature descriptor data point to a first set of addresses associated with a first set of buckets out of the plurality of buckets, and each of the first set of buckets storing the one second feature descriptor data point.

8. A computer-implemented method for identifying and displaying additional information relating to an image obtained by a user with a mobile device, the method comprising:

acquiring at least one image using the mobile device, the at least one image comprising at least one item of interest to the user about which the user wishes to receive additional information;

extracting one or more first features from the at least one image, the one or more first features corresponding to the at least one item of interest;

generating a first fingerprint representing the one or more first features;

transmitting, to a server, a first query including the first fingerprint, the fingerprint allowing the server to acquire one or more second images and determine, based on one or more second images selected based on the first query, that the server has additional information relating to the at least one item of interest to the user; and

receiving, from the server, the additional information relating to the at least one item of interest to the user and displaying the additional information to the user.

9. The computer-implemented method of claim 8, further comprising:

receiving, via the first interface on the mobile device, a user's selection of a portion of the first image;

wherein extracting one or more first features from the at least one image comprises extracting one or more first features corresponding to the selected portion; and

wherein generating a first fingerprint comprises generating a first fingerprint representing the one or more first features extracted from the selected portion of the first image.

10. A device for identifying and displaying additional information relating to an item of interest, the device comprising a processor for executing one or more modules comprising:

an image acquisition module for acquiring an image including the item of interest;

a feature descriptor generation module for extracting one or more image feature quantities associated with the image;

a fingerprint generation module for:

generating a query fingerprint based on the extracted one or more image feature quantities; and

transmitting the query fingerprint to a server, wherein the query fingerprint allows the server to perform, based on the query fingerprint, a similarity search in a database storing one or more reference feature descriptors and to acquire one or more candidate images associated with at least one of the one or more reference feature descriptors based on a result of the similarity search;

an image matching module for determining whether the image matches with the one or more candidate images; and

an additional database module for acquiring, based on the determination at the image matching module, additional information associated with at least one of the one or more candidate images for displaying as additional information relating to the at least one item of interest to the user.

CLAIMS

1. A server for identifying and transmitting to a mobile device additional information relating to a query image obtained by a user with a mobile device, the server comprising:
 - a reference image database storing one or more reference feature descriptors associated with one or more reference images, wherein at least one reference image feature descriptor is mapped to a plurality of first addresses within an address space in the reference image database using a plurality of functions, and wherein the plurality of functions is configured to map one or more feature descriptors to the same address space; and
 - a processor for executing one or more modules comprising:
 - a query receiving module for receiving, from the mobile device, a first query including one or more query image feature descriptors;
 - a candidate feature descriptors retrieval module for:
 - calculating, for each of the one or more query image feature descriptors, a plurality of second addresses using the plurality of functions, and
 - for each of the plurality of second addresses, determining a number of duplicate reference image feature descriptors stored within a pre-defined region of the reference image database;
 - a candidate images retrieval module for:
 - selecting a set of reference image feature descriptors based on the determined number of duplicate reference image feature descriptors;

an image matching module for:

comparing the selected set of reference image feature descriptors
with the one or more query image feature descriptors to
determine if any one of the one or more reference images
match the query image;

wherein, if a matching reference image is determined, the server is further
configured to perform the steps of
obtaining additional information associated with the at least one
matching reference image from an annotation database, and

transmitting the additional information to the mobile device for
displaying as additional information relating to the at least one item
of interest to the user.

2. The server of claim 1, wherein the processor is further configured to execute a hash table management module for:

providing, for each of the plurality of second addresses, one or more
references to one or more of the reference image feature
descriptors based on a relationship between each of the plurality of
second addresses and each of the plurality of the first addresses;

and wherein the number of duplicate reference image feature descriptors
is determined based on the relationship.

3. The server of claim 2, wherein the hash table management module further
comprises a collision resolving module for:
using a random function to calculate the plurality of the first addresses.

4. A computer-implemented method for identifying and displaying additional information relating to a first query image obtained by a user with a mobile device, the method comprising:

receiving, from the mobile device, a first query including one or more query image feature descriptors corresponding to at least one item of interest to the user included in the first query image;

responsive to receiving the first query, performing a similarity search, wherein the similarity search comprises:

for each of the query image feature descriptors, calculating a plurality of addresses using a plurality of functions;

for each of the plurality of addresses, determining a number of duplicate reference image feature descriptors stored within a certain region of a reference image database storing one or more reference image feature descriptors, each of the reference image feature descriptors being associated with at least one reference image, wherein at least one reference image feature descriptor is mapped to a plurality of addresses within an address space in the reference image database using the plurality of functions, and wherein the plurality of functions is configured to map one or more feature descriptors to the same address space; and

determining one or more candidate reference images based on a number of duplicate reference image feature descriptors within the certain region of the reference image database associated with each of the plurality of addresses;

comparing the feature descriptors for the one or more candidate reference images to the query image feature descriptors to determine if there is a match; and

if there is a match, acquiring additional information associated with the match; and

transmitting, to the mobile device, the additional information associated with the match for displaying to the user.

5. The computer-implemented method of claim 4,

wherein the number of duplicate reference image feature descriptors within a pre-defined region associated with an address reflects a degree of similarity between the duplicate reference image feature descriptors and the first query image feature descriptors mapped to the address;

and wherein the determination of one or more candidate reference images comprises:

determining that the number of duplicate reference image feature descriptors exceeds a pre-determined threshold; and
acquiring the one or more candidate reference images associated with the duplicate reference image feature descriptors.

6. The computer-implemented method of claim 5, further comprising:

receiving, from the mobile device, a second query including one or more second query image feature descriptors;

comparing the one or more first query image feature descriptors with the one or more second query image feature descriptors; and

based on a result of the comparison:

determining not to perform the similarity search; and

acquiring, based on a mapping between the first query and the one or more candidate reference images stored in a query cache, the one or more candidate images.

7. The computer-implemented method of claim 4, wherein
the reference image feature descriptors are stored within a database based on a hash table including a plurality of hash buckets, each hash bucket being associated with an address,

each hash bucket being associated with an address within the address space;
wherein the plurality of functions are configured to map one or more feature descriptors to one or more hash buckets of out the same set of hash buckets.

8. The server of claim 1, wherein each of the plurality of first addresses is associated with a single reference image feature descriptor.

9. The server of claim 2, wherein the hash table management module further comprises an overflowing handling module for:

determining whether the one of the plurality of first addresses is associated with a first reference image feature descriptor when the one of the plurality of first addresses is calculated;
responsive to determining that the one of the plurality of first addresses is associated with the first sentence image feature descriptor:

disassociating the one of the plurality of first addresses from the first reference image feature descriptor; and
associating the one of the plurality of first addresses with a second reference image feature descriptor.

10. The server of claim 1, wherein the processor is further configured to execute the candidate images retrieval module for:

ranking one or more sets of reference image descriptors, each set being associated with a combination of the determined numbers of duplicate reference image feature descriptors; and
selecting the set of reference image feature descriptors based on a result of the ranking.

11. The server of claim 1, wherein the processor is further configured to execute the candidate images retrieval module for:

excluding, from the selected set of reference image feature descriptors, one or more reference images associated with a calculated number of duplicate reference image feature descriptors that is below a predefined threshold.

12. The server of claim 1, wherein the reference image descriptors are stored within the databased based on a hash table including a plurality of hash buckets, each hash bucket being associated with an address within the address space; wherein the plurality of functions are configured to map one or more feature descriptors to one or more hash buckets out of the same set of hash buckets.

13. The computer-implemented method of claim 4, further comprising:

receiving, from the mobile device, a second query including or ore more second query image feature descriptors;

comparing the one or more first query image feature descriptors with the one or more second query image feature descriptors; and
based on a result of the comparison:
determining not to perform a similarity search; and
acquiring, based on a mapping between the first query and the one or more candidate reference images stored in a query cache, the one or more candidate images.

14. A device for identifying and displaying additional information relating to an item of interest, the device comprising a processor for executing one or more modules comprising:

- an image acquisition module for acquiring a first query image including the item of interest;
- a feature descriptor generation module for extracting a plurality of first query image feature descriptors associated with the first query image;
- a fingerprint generation module for:
 - generating a first query fingerprint based on the extracted first query image feature descriptors; and
 - transmitting the first query fingerprint to a server, wherein the first query fingerprint enables the server to perform, based on the first query fingerprint, a similarity search in a database storing a plurality of reference image feature descriptors and to acquire one or more candidate images associated with at least one of the reference image feature descriptors retrieved from the database by mapping the query feature descriptors to addresses, or adjacent addresses, to which reference image feature descriptors are most frequently mapped; and
- an image matching module for determining whether the first query image matches with at least one of the one or more candidate images;

wherein the determination at the image matching module enables acquisition of additional information associated with at least one of the one or more candidate images for displaying as additional information relating to the at least one item of interest to the user.

15. The device of claim 14, wherein the processor is further configured to execute the image matching module for:

estimating a first set of relative positions between the first query image feature descriptors;

for at least one of the one or more candidate images:

determining a set of corresponding reference image feature descriptors that correspond to the first query image feature descriptors;

calculating a second set of relative positions between the set of corresponding feature descriptors; and

determining a degree of fit between the first query image and the candidate image based on a relationship between the first set of relative positions and the second set of relative positions;

wherein the determination of whether the first query image matches with at least one of the one or more candidate images is based on the determined degree of fit.

16. The device of claim 15, wherein the determining of the set of corresponding feature descriptors that correspond to the first query image feature descriptors comprises calculating one or more feature distances between one or more reference image feature descriptors and the first query image feature descriptors.

17. The device of claim 15, wherein the device is further configured to perform the steps of:

determining a first pose of the first query image based on the first set of relative positions;

comparing the first pose with a second pose associated with a previously acquired query image;
based on a result of the comparison, determining whether a tracking is lost;
and
when it is determined that a tracking is lost:
causing the image acquisition module to acquire a second query image;
causing the feature descriptor generation module to extract a plurality of second query image feature descriptors associated with the second query image; and
causing the fingerprint generation module to:
generate a second query fingerprint based on the extracted second query image feature descriptors; and
transmit the second query fingerprint to the server.

18. The device of claim 14, wherein the processor is further configured to execute the image acquisition module for:
acquiring a plurality of images;
associating each of the acquired plurality of images with each of a plurality of first timestamps;
detecting an initiation to take a snapshot;
associating the initiation with a second timestamp; and
selecting an image out of the plurality of images as the first query image based on a relationship between each of the plurality of first timestamps and the second timestamp.

19. The device of claim 18, wherein the processor is further configured to execute the image acquisition module for detecting a motion of the device; wherein the selection of the image out of the plurality of images as the first query image is also based on the detected motion.

20. The device of claim 14, further comprising:
- a query cache for storing a mapping between one or more previously-received query fingerprints and one or more previously-acquired candidate images; and
 - a query cache management module for determining whether the first query fingerprint matches with any of the one or more previously-received query fingerprints stored in the query cache;
- wherein, if the query cache management module determines that the first query fingerprint matches with at least one of the one or more previously-received query fingerprints stored in the query cache, the device is further configured to perform the steps of:
- determining not to transmit the first query fingerprint to the server; and
 - causing the image matching module to determine whether the first query image matches with any of the previously-acquired candidate images.
21. The device of claim 20, wherein, if the query cache management module determines that the first query fingerprint matches with none of the one or more previously-receive query fingerprints stored in the query cache, the device is further configured to perform the step of:
- after the image matching module determines that the first query image matches with at least one of the one or more candidate images, adding a mapping between the first query fingerprint and the one or more candidate images to the query cache.
22. The device of claim 14, wherein the device is further configured to perform the steps of:
- providing an interface to receive a selection of a portion of the first query image; and

causing the feature descriptor generation module to extract the first query image feature descriptors associated with the selected portion of the first query image.

23. The device of claim 14, wherein the device is further configured to perform the steps of:

providing an interface to receive a selection of a portion of the first query image; and

causing the additional database module to acquire the additional information based on the selection.

24. The device of claim 14, wherein at least one reference image feature descriptor is mapped, with a plurality of functions, to a plurality of addresses within an address space in the database; and wherein the plurality of functions is configured to map one or more feature descriptors to the same address space.

25. The device of claim 24, wherein the similarity search includes determining a number of duplicate reference image feature descriptors within a pre-defined region of the database, wherein the pre-defined region of the database is associated with one or more addresses calculated from the first query image feature descriptors included in the first query fingerprint using the plurality of functions.

26. A computer-implemented method for identifying and displaying additional information relating to an image obtained by a user with a mobile device, the method being implemented by the mobile device and comprising:

acquiring a first query image comprising at least one item of interest to the user about which additional information is to be displayed;

extracting a plurality of first features from the first query image, wherein the first features correspond to the at least one item of interest;

generating a first query, wherein the first query includes the extracted first features;
transmitting the first query to a server, wherein the first query enables the server to acquire one or more reference images by mapping the query feature descriptors to addresses, or adjacent addresses, to which reference image feature descriptors are most frequently mapped and to determine, based on the one or more reference images acquired based on the first query, that the server stores additional information about the at least one item of interest; and
receiving, from the server, the additional information about the at least one item of interest; and
displaying the additional information about the at least one item of interest to the user.

27. The computer-implemented method of claim 26, further comprising:
receiving, via an interface on the mobile device, a user's selection of a portion of the first query image;
wherein extracting a plurality of first features from the first query image comprises extracting a plurality of first features corresponding to the selected portion; and
wherein generating a first query comprises generating a first query representing the extracted first features corresponding to the selected portion.
28. The computer-implemented method of claim 26, further comprising:
storing the extracted first features;
acquiring a second query image;
extracting a plurality of second features from the second query image;
determining a relationship between the stored first features and the extracted second features; and

based on the relationship, determining not to transmit a second query including information representing the extracted second features to the server.

29. The computer-implemented method of claim 26, wherein the acquired one or more reference images are associated with a plurality of second features; wherein duplicates of at least one of the second features are stored within a pre-defined region associated with an address calculated from the first features.