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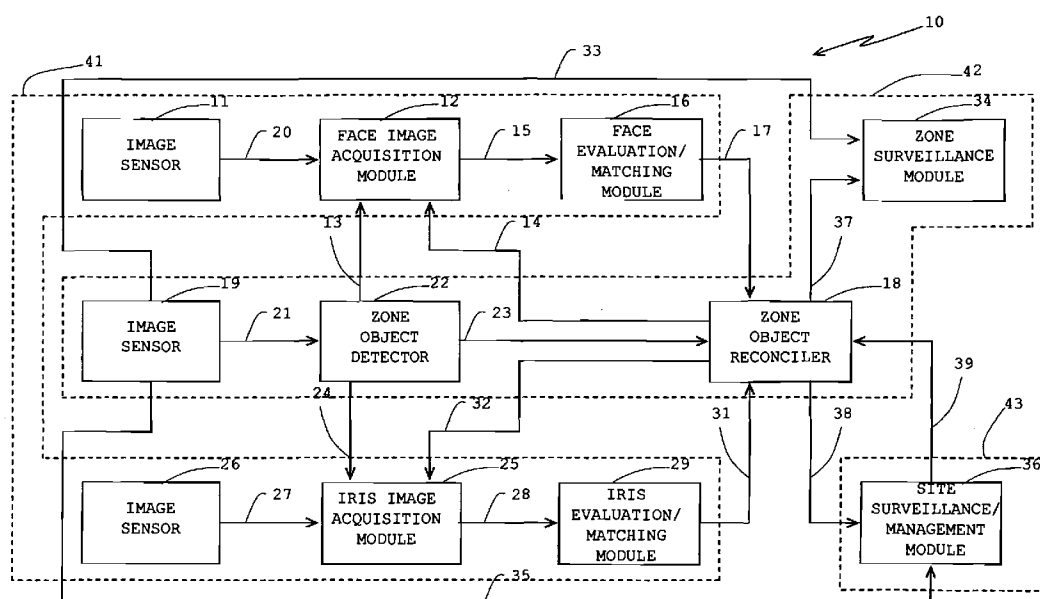
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(54) Title: MODULAR BIOMETRICS COLLECTION SYSTEM ARCHITECTURE



(57) Abstract: A modular biometrics collection system with an architecture having application to a combined features recognition system. The system may be a self-organizing mesh of collaborative independent components. Each component may have inputs, outputs, and local prioritization management. Each component may operate autonomously. Federated behavior of the components may be achieved by subscribing to content that influences local prioritization. An example of the system may have application to combined face and iris recognition.

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MODULAR BIOMETRICS COLLECTION SYSTEM ARCHITECTURE

This application claims the benefit of U.S. Provisional Application No. 60/778,770, filed March 3, 2006.

The government may have rights in the present invention.

Background

The present invention pertains to recognition systems and particularly to biometric recognition systems. More particularly, the invention may pertain to collection architecture of the recognition systems.

U.S. Patent Application No. 10/979,129, filed November 3, 2004, is hereby incorporated by reference.

U.S. Patent Application 10/655,124, filed September 5, 2003, is hereby incorporated by reference.

U.S. Patent Application 11/382,373, filed May 9, 2006, is hereby incorporated by reference.

U.S. Provisional Application No. 60/778,770, filed March 3, 2006, is hereby incorporated by reference.

U.S. Patent Application No. 11/275,703, filed January 25, 2006, is hereby incorporated by reference.

U.S. Provisional Application No. 60/647,270, filed January 26, 2005, is hereby incorporated by reference.

U.S. Patent Application No. 11/043,366, filed January 26, 2005, is hereby incorporated by reference.

U.S. Patent Application No. 11/372,854, filed March 10, 2006, is hereby incorporated by reference.

U.S. Patent Application No. 11/672,108, filed February 7, 2007, is hereby incorporated by reference.

U.S. Patent Application No. 11/675,424, filed February 15, 2007 is hereby incorporated by reference.

Summary

The present invention is modular biometrics collection system architecture applicable to system such as sensing and acquisition systems.

Brief Description of the Drawing

Figure 1 is a diagram of an example system utilizing biometrics collection system architecture;

Figure 2 is a diagram of a different scale system than the system in the diagram of Figure 1, having fewer biometrics sensors; and

Figure 3 is a diagram of a system in which multiple system scopes utilize a common sensor as compared to the system in the diagram of Figure 2.

Description

The present system architecture may relate to biometrics, iris recognition systems, image quality metrics, authentication, access control, monitoring, identification, and security and surveillance systems.

A biometric information acquisition system that incorporates multiple acquisition components, maximizing the amount and quality of the collected content, should be very flexible and adaptive, allowing essentially any collected content to influence the collection behavior of any collection component. A conventional design approach for this kind of system may be to perform an extensive static analysis a priori, and design an architecture and system organization for implementing the analysis results. This more generalized information acquisition problem space may be better suited for a collaborative architecture that exhibits local autonomy and federated behavior.

The present system may be constructed as a self-organizing mesh of collaborative independent components. Each component may have inputs, outputs, and local prioritization / management. An input may be physical such as a sensor or content produced by another component. An output may be content that could be used as input to another component or a physical surface such as a display. The local prioritization may determine how and/or when inputs are used. Then operations may be performed and outputs produced based on locally relevant evaluation of local values and evaluation of external values received as inputs. Inputs and outputs may be shared using a producer/consumer paradigm. That is, the producer of outputs may have no knowledge of the number of consumers or how the outputs will be used, and the consumer may subscribe to content abstractly by a content identifier and quality of service, potentially without knowledge of the producer. Each component may operate autonomously, acting on its inputs upon their arrival and producing outputs from them as dictated by its own prioritization. Federated behavior may be achieved incorporating a component of larger scope that subscribes to content produced by smaller scope components, and produces guidance content that the small scope components may subscribe to and use to influence their local prioritization.

One may analyze a problem space. The system may be partitioned into components identified by inputs, outputs, and independence from other components, and general reusability of defined content. Content may be defined using an abstraction applicable to a broad application scope.

One may identify types of information needed for collaboration guidance that might not otherwise be

produced in the system, identify candidate producers, and define as produced content.

One may define identification, characteristics, and interchange encoding for each type of content. To the extent feasible, use content descriptions that already exist, or add backward compatible extensions to existing content definitions, to permit newer producers to be used with existing systems.

A coordinate system may be utilized that is relative within the immediate scope. For example, information within a zone may be exchanged in zone scoped rectangular coordinates. An aiming component within a zone may be configured to know its location and orientation, and it can determine how to aim from zone coordinates. Information within a site may be exchanged in site scoped rectangular coordinates, and any entity exchanging information outside its zone must know the zone's site location and orientation, and perform the coordinate scoping transformation. The parameters necessary to make these transformations must be available from the next level up in the hierarchy.

For description purposes, one may consider a multiple biometric system acquiring both face and iris recognition biometrics from fields of view, or zones (see Figure 1). This system may operate at three levels--a site level, a zone level, and a biometrics level.

At the site level may be surveillance and/or management entities that serve as aggregators of multiple zones. For an example system, a site surveillance module may typically subscribe to zone images, and reconcile match results (i.e., matched) to present an overview of the scene activities, but when "zooming in", it could temporarily subscribe to any content to present a detailed view of the current zone state/activity. The

site management module may subscribe to reconciled match results, and provide functionality such as coordination across multiple zones. The coordination may be materialized as prioritizing guidance content.

At the zone level, a zone object detector may identify and publish coordinates of objects of interest, using the same identifier for objects that are likely-to-be the same entity, and the zone object reconciler may fuse biometric content taking object identifiers into account. The results may be published as reconciled match results.

At the biometrics level, acquisition and evaluation/matching modules may obtain suitable quality images from the coordinates specified with objects in zone, perform matching, and publish the evaluation and match results. These modules or components may operate autonomously, prioritizing the objects in the zone to optimize the number and quality of biometrics as appropriate for the current set of detected objects in the scene. External content including reconciled match results and prioritizing guidance may be factored into the prioritization.

An example biometric system may produce / consume multiple kinds of content. There may be camera and/or sensor inputs. There may be a zone image which is an image of a region being observed. There may be objects in a zone which can have coordinates and the size of a region in a zone image identified as being of interest. A face image may be correlated to a zone object. There may be an image having an object which can be identified as a face of sufficient quality for recognition at object coordinates. Face match results may be a report on results of a matching operation using a specified face image. An iris image may be correlated to zone object.

It may be an image identified as an iris of sufficient quality for recognition at object coordinates. Iris match results may be a report on results of a matching operation using a specified iris image. Reconciled match results may be an assessment of identification and relationship between biometric artifacts with respect to objects in a zone. Prioritizing guidance may be information from a larger scope of the system intended to influence local prioritization of potential objects in a zone.

The example system may have various components, modules, and/or the like. There may be a zone object detector which has an input from a camera sensor. Its activity may include collecting images of the zone, analyzing the images, and identifying objects of interest. An identification (ID) may be assigned to each new object. The output content may include zone image and object information. There may be face image acquisition which has inputs of a camera sensor, objects in a zone, reconciled match results, and prioritizing guidance. Its activity may include prioritizing known objects, zooming to a face at object coordinates, and obtaining a sufficient quality image for a face match. Its output content may include a face image correlated to a zone.

There may be iris image acquisition having inputs of a camera sensor, objects in a zone, reconciled match results, and prioritizing guidance. Its activity may include prioritizing known objects, zooming to a face (iris) at object coordinates, and obtaining a sufficient quality image for an iris match. Its output content may include face biometric data correlated to a zone object. There may be face evaluation/matching having an input of face biometric data correlated to a zone object. Its

activity may include processing the biometric data to extract recognition criteria (biometric artifact) and looking up a face biometric artifact in a recognition database. Its output content may include biometric artifacts and face match results. There may be iris matching having an input of an iris biometric data correlated to a zone object. Its activity may include processing the biometric data to extract recognition criteria (biometric artifact) and looking up an iris biometric artifact in a recognition database. Its output content may include iris match results.

There may be a zone object reconciler having inputs of objects in a zone, face match results, and iris match results. Its activity may include analyzing match results, matching conflicts, using affinity measures to resolve conflicts, auto enrolling as appropriate, and so forth. Its output content may include biometric artifacts, multi-biometric match results and image acquisition guidance.

There may be zone surveillance having input content selected for display such as zone images, biometric artifacts, and multi-biometric match results. Its activity may include displaying a zone image, match results, and so forth, as appropriate for the zone scope of an observation. Its output may include visual display. There may be site surveillance / management having input content from multiple zones selected for display such as zone images and reconciled match results. Its activity may include displaying multiple individual/consolidated zone images, match results, and so forth, as appropriate for the site scope of observation. Its output may include visual display and prioritizing guidance (to zone scope).

A collection system may have a biometric scope, a zone scope and a site scope. The zone scope may produce guidance content for the biometric scope and consume content produced by the biometric scope. The site scope may produce guidance content for the zone scope and consume content produced by the zone scope. The biometric scope may have a sensing module, an acquisition module that consumes content produced by the sensing module, and an evaluation module that consumes content produced by the acquisition module.

Figure 1 shows an example system 10 implementing the present system architecture. An image sensor 11 may output an image to a face image acquisition module 12. The image may have a face which is acquired by module 12. Known objects may be prioritized by module 12. The face at object coordinates may be zoomed to by the module. A sufficient quality image for a match may be obtained. The image may be correlated and published. Input 13 content may include objects in a zone. Input 14 content may include reconciled match results and prioritizing guidance. An output 15 may have content of a face biometric data correlated to a zone object. Output 15 may go to a face evaluation/matching module 16. Module 16 may extract a face biometric artifact from the biometric data and look up the face biometric artifact in a recognition database. Biometric artifact and face match results may be published as content in an input 17 to a zone object reconciler 18.

An image sensor 19 may provide images 21 of its visible region to a zone object detector 22. Detector 22 may receive images 21, analyze them, and identify objects of interest. An identification label (ID) may be assigned to each new object. The zone image and object information may be published by the detector 22. Content

of output 23 from detector 22 may include information locating objects in the zone which may go to reconciler 18. The same content may be provided as the input 13 to the face image acquisition module 12. Also, this content may be provided as an input 24 to an iris image acquisition module 25.

An image sensor 26 may provide images 27 of a face including images of an eye and iris to the iris image acquisition module 25. Module 25 may prioritize known objects, zoom to the face at object coordinates, obtain a sufficient quality image for a match and produce a correlated image as biometric data content. The content of an output 28 as an input to an iris evaluation/matching module 29 may include iris biometric data correlated to a zone object. The iris matching module 29 may extract an iris biometric artifact from the biometric data and look up the iris biometric artifact in a recognition database and produce the iris match results. An output 31 of module 29 may provide iris biometric artifacts and iris match results as content to the zone object reconciler 18. Reconciler 18 may provide an output as an input 32 having multi-biometric match results and prioritizing guidance as content to the iris image acquisition module 25.

Image sensor 19 may provide zone image content as an input 33 to a zone surveillance module 34 and as an input 35 to a site surveillance / management module 36. The zone object reconciler 18 may provide reconciled match results as content for an input 37 to the zone surveillance module 34 and for an input 38 to the site surveillance / management module 36. Module 36 may be a site of numerous zones, for example, zones A, B, C, D, E, F, G, H, and so on. These zones may be areas of surveillance, for instance. Content from site scope

module 36 may consist of prioritizing guidance which is an input 39 to the zone object reconciler 18.

The zone surveillance module 34 may have a display output. A zone image may be displayed, match results, and so forth, as appropriate for the present scope of observation.

System 10 may have a biometric scope 41, a zone scope 42 and a site scope 43, which could be modules. Biometric scope 41 may be interactively connected to zone scope 42. Zone scope 42 may be interactively connected to site scope 43. Image sensor 11, face acquisition module 12, face matching module 16, image sensor 26, iris image acquisition module 25 and iris matching module 29 may be of the biometric scope 41. Image sensor 19, zone object detector 22, zone object reconciler 18 and zone surveillance module 34 may be of the zone scope 42. Site surveillance / management module 36 may be of the site scope 43. Modules may be at various levels.

Figure 2 is a diagram of a system 30 which may be a more general level instantiation of the present invention than the diagram of Figure 1. A sensing module 44 may be connected to an acquisition module 45. The acquisition module 45 may be connected to an evaluation module 46. A biometric scope 41 may include modules 44, 45 and 46. A sensing module 47 may be connected to a zone object detector / reconciler 48 and to a zone surveillance module 34. The zone object detector / reconciler 48 may be connected to the acquisition module 45, the evaluation module 46 and the zone surveillance module 34. A zone scope may include sensing module 47, zone object detector / reconciler 48 and zone surveillance module 34. A site surveillance / management module 36 may be connected to the sensing module 47 and the zone object detector /

reconciler 48. A site scope 43 may include the site surveillance / management module 36.

Sensing module 44 may have one or more image or other sensors for detecting various kinds of items such as people, animals, inanimate objects, and features of those people, animals, inanimate objects, and so forth. The acquisition module 45 may acquire or extract features, activities, and/or patterns of activities, of the sensed items. The evaluation module 46 may provide such things as matching, grading, thresholding, and so forth, of those items of module 45. Sensing module 47 may provide one or more images or have other sensors to detect various items like those detected by module 44. The zone object detector / reconciler 48 may include a zone object detector and a zone object reconciler, which may be similar, but not necessarily, to the detector 22 and reconciler 18 of Figure 1, respectively.

Figure 3 is a diagram of a system 40 which is similar to system 30. Biometric scope 41 may overlap zone scope 42. A reason for an overlay is that the operations, functions, mechanism and the like of modules 44 and 47 may be combined into a sensing module 49.

In the present specification, some of the matter may be of a hypothetical or prophetic nature although stated in another manner or tense.

Although the invention has been described with respect to at least one illustrative example, many variations and modifications will become apparent to those skilled in the art upon reading the present specification. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the prior art to include all such variations and modifications.

What is claimed is:

1. A collection system comprising:
 - a biometric scope;
 - a zone scope for producing guidance content for the biometric scope and consuming content produced by the biometric scope; and
 - a site scope for producing guidance content for zone scope and consuming content produced by the zone scope.
2. The system of claim 1, wherein the biometric scope comprises:
 - a sensing module for producing sensor outputs;
 - and
 - an acquisition module for consuming sensor outputs and producing biometric data; and
 - an evaluation module for consuming biometric data and producing biometric artifacts.
3. The system of claim 1, wherein the zone scope comprises:
 - a sensing module for producing sensor outputs;
 - and
 - a zone object detector for consuming sensor outputs and producing object of interest locations; and
 - a zone object reconciler for consuming biometric artifacts and correlating the independently produced artifacts with respect to common objects of interest identifiers; and
 - a zone surveillance module for consuming sensor outputs and correlated biometric

artifacts, and presenting them to a user interface for surveillance purposes.

4. The system of claim 2, wherein:
 - the sensing module comprises one or more image sensors; and
 - the acquisition module comprises one or more feature image acquisition modules connected to the sensing module.
5. The system of claim 4, wherein the evaluation module comprises one or more matching modules.
6. The system of claim 2, wherein:
 - the sensing module comprises one or more image sensors; and
 - the acquisition module comprises:
 - a face image acquisition module connected to one or more image sensors;
 - a face matching module connected to the face image acquisition module;
 - an iris image acquisition module connected to one or more image sensors; and
 - an iris matching module connected to the iris image acquisition module.
7. A biometric collection method comprising:
 - zone object detection having sensor input;
 - face image acquisition having sensor input and receiving content with objects in a zone;
 - face matching receiving content with a face image correlated to an object in a zone;

zone object reconciling receiving content with
face matching results and content with
objects in a zone; and
zone surveillance receiving content with a zone
image and content with reconciled matching
results.

8. The method of claim 7, further comprising:
iris image acquisition having sensor input and
receiving content with objects in a zone;
and
iris matching receiving content with an iris
image correlated to an object in a zone;
and
wherein the zone object reconciling can receive
content with iris matching results.

9. The method of claim 8, further comprising site
surveillance and/or management of one or more zones,
receiving content with reconciled matching results
and with a zone image.

10. The method of claim 9, wherein the zone object
reconciling can receive content with prioritizing
content from the site surveillance and/or management
of one or more zones.

11. The method of claim 10, wherein:
the face image acquisition can receive content
with reconciled matching results and
prioritizing guidance; and
the iris image acquisition can receive content
with reconciled matching results and
prioritizing guidance.

12. The method of claim 11, wherein:
the face image acquisition can prioritize
objects, zoom to a face at object
coordinates and/or obtain a face image
having sufficient quality for matching;
and
the iris image acquisition can prioritize
objects, zoom to a face, eye or iris at
object coordinate and/or obtain a face,
eye or iris image having sufficient
quality for matching.
13. The method of claim 11, wherein:
the zone object detection can collect images of
a zone, analyze the images, identify
objects of interest in the images, and/or
assign an identification to each new
object; and
the zone object reconciling can analyze
matching results, match conflicts, resolve
conflicts, resolve conflicts, auto enroll
as appropriate and/or the like.
14. The method of claim 11, wherein the zone
surveillance can display a zone image, matching
results and so forth, as appropriate for a present
scope of observation.
15. A biometric collection system architecture
comprising:
biometric scope;
a zone scope having an interactive connection
with the biometric scope; and

a site scope having an interactive connection with the zone scope.

16. The architecture of claim 15, wherein the biometric scope comprises:

a first sensing module;
an acquisition module having an interactive connection with the sensing module; and
an evaluation module having an interactive connection with the acquisition module.

17. The architecture of claim 16, wherein the zone scope comprises:

a second sensing module;
a zone object detector/reconciler having an interactive connection with the second sensing module, the acquisition module and the evaluation module; and
a zone surveillance module having an interactive connection with the second sensing module and the zone object detector/reconciler.

18. The architecture of claim 17, wherein the site scope comprises a site surveillance/management module interactive connection with the second sensing module and the zone object detector/reconciler.

19. The architecture of claim 18, wherein:
the sensing module is for sensing images of people;

the acquisition module is for obtaining face images and iris images from the images of people; and

the evaluation module is for matching face images with face images in a database and for matching iris images with iris images in a database.

20. The architecture of claim 19, wherein the zone object detector/reconciler comprises:

a zone object detector connected to the second image sensor and the acquisition module; and

a zone object reconciler connected to the zone object detector, the acquisition module, the evaluation module, the site surveillance/management module and the zone surveillance module.

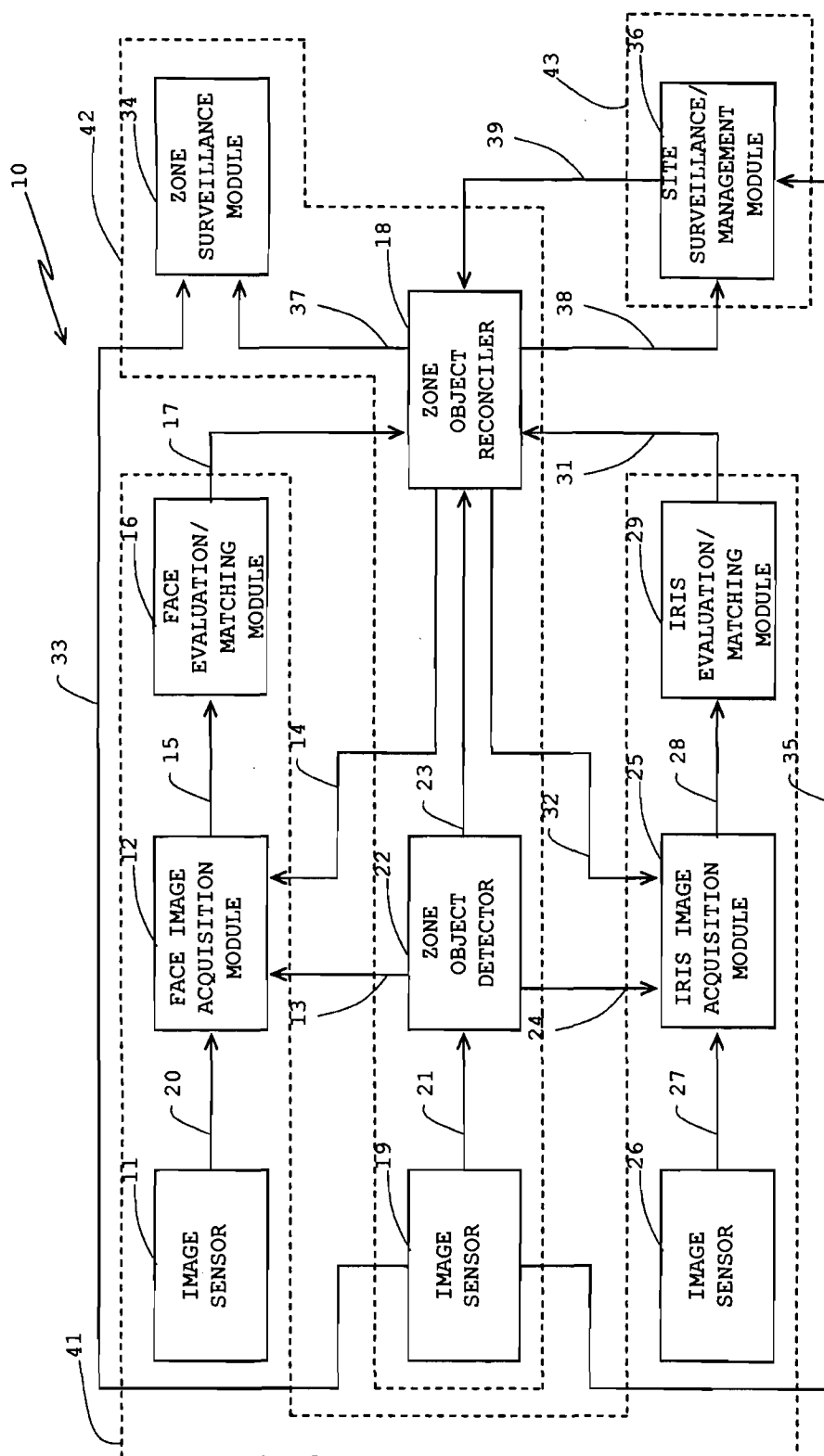


FIGURE 1

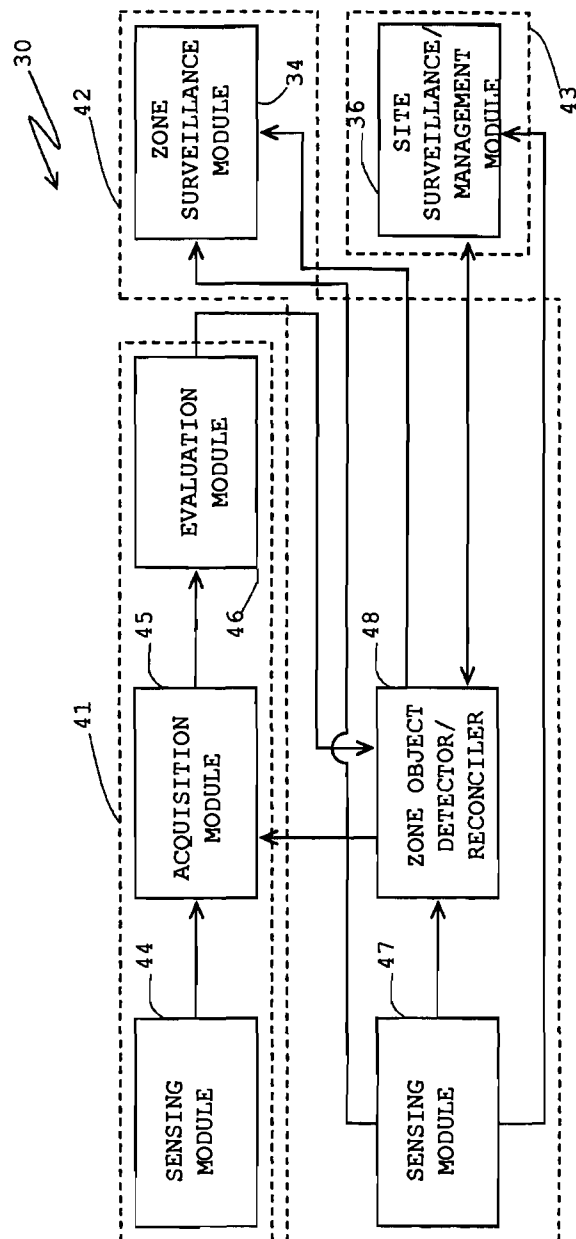


FIGURE 2

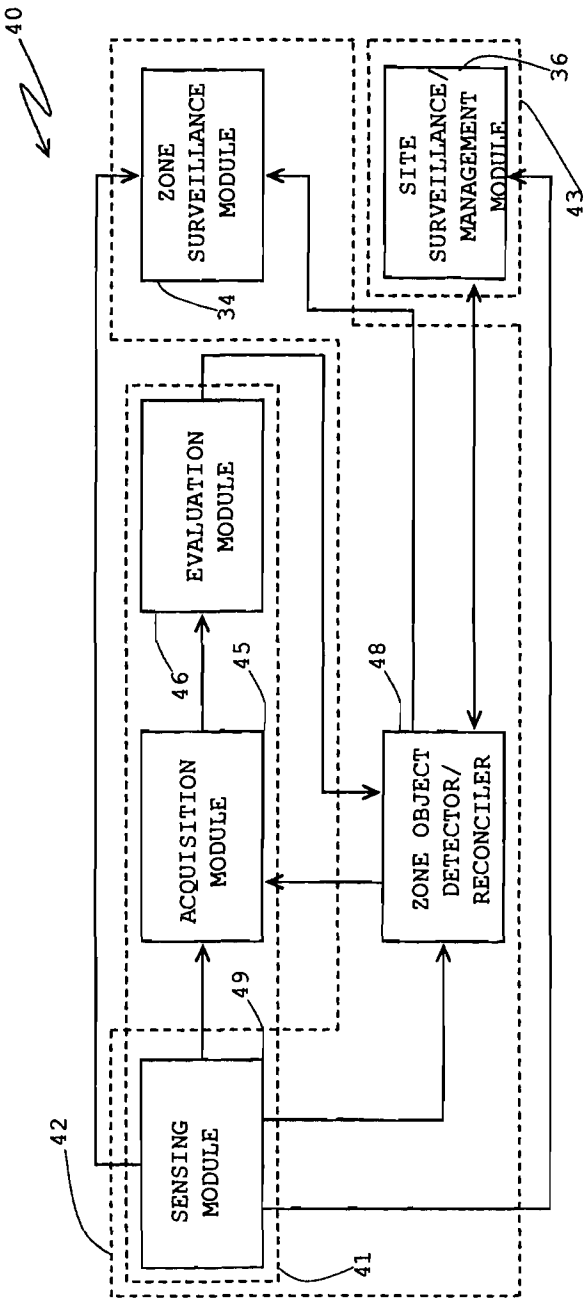


FIGURE 3