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UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF CALIFORNIA

PARK ASSIST, LLC, Plaintiff, v. SAN DIEGO COUNTY REGIONAL AIRPORT AUTHORITY; ACE PARKING MANAGEMENT, INC., Defendant.	CASE NO. '18CV2068 LAB MDD **COMPLAINT FOR PATENT INFRINGEMENT** **JURY DEMANDED**

Park Assist LLC ("Park Assist" or "Plaintiff"), for its Complaint against Defendant San Diego County Regional Airport Authority ("SDCRAA") and Defendant Ace Parking Management, Inc. ("Ace Parking") (collectively, "Defendants"), alleges as follows:

THE PARTIES

1. Park Assist is a Delaware limited liability company with its principal place of business at 57 W 38th Street, 11th Floor, New York, NY 10018.

2. On information and belief, SDCRAA is a local government entity created by act of the California State Legislature with jurisdiction throughout the County of San Diego and operates the San Diego International Airport ("Airport") located in San Diego, California. See California Public Utilities Code § 170002.

3. On information and belief, Ace Parking is a California corporation having a principle place of business at 645 Ash Street, San Diego, California 92101.

JURISDICTION AND VENUE

4. Subject matter jurisdiction is based on 28 U.S.C. §§ 1331 and 1338, and this action arises under the patent laws of the United States (35 U.S.C. § 100, et seq.).

5. This Court has personal jurisdiction over SDCRAA at least because, on information and belief, SDCRAA among other things, has continuous and systematic contacts with the State of California and conducts regular business in this District, and on information and belief, has a substantial presence and contacts within this District including by operating the Airport, selling and/or offering for sale products and services in this District in its operation of the Airport, and by being a local governmental entity of the regional San Diego County government. See also California Public Utilities Code § 170032.

6. This Court has personal jurisdiction over Ace Parking at least because, on information and belief, Ace Parking among other things, has continuous and systematic contacts with the State of California and conducts regular business in this District, and on information and belief, has a substantial presence and contacts within this District including by selling and/or offering for sale services in this District, including parking management services at the Airport and by being

incorporated and registered to do business within the State of California.

7. Venue lies in this Court pursuant to 28 U.S.C. §1400(b) because, inter alia, each Defendant resides in the District and, on information and belief, each Defendant has committed and continues to commit acts of infringement in the District and maintains its principle place of business in this District, such that this District has sufficient interest in resolving this dispute.

THE PATENT-IN-SUIT

8. United States Patent No. 9,594,956 ("'956 Patent"), entitled "Method and System for Managing a Parking Lot Based on Intelligent Imaging," was duly and legally issued by the United States Patent and Trademark Office on March 14, 2017, and is still in full force and effect.

9. Park Assist is the owner of the '956 Patent, a true and correct copy of which is attached as Exhibit A.

SAN DIEGO INTERNATIONAL AIRPORT AND ACE PARKING

10. Park Assist repeats and realleges the allegations of paragraphs 1-9 of the Complaint as if set forth fully herein.

11. On information and belief, SDCRAA has implemented and operates a parking guidance system at the Airport's Terminal 2 Parking Plaza ("Airport Parking System") as reported in the San Diego Union Tribune website article on the Airport Parking System, dated May 17, 2018, a true and correct copy of which is attached as Exhibit B [http://www.sandiegouniontribune.com/business/tourism/sd-fi-airport-parking-20180516-story.html].

12. On information and belief, SDCRAA, by way of its employees and/or jointly with Ace Parking, operates the Airport Parking System. A printout of a true and correct copy of the Airport's "Parking FAQ" webpage stating that "Parking management services [are] provided by Ace Parking" is attached as Exhibit C. (http://www.san.org/parking/faq/QuestionID/225/AFMID/5711)

INFRINGEMENT OF U.S. PATENT NO. 9,594,956

13. Park Assist repeats and realleges the allegations of paragraphs 1-12 of the Complaint as if fully set forth herein.

14. On information and belief, either individually, and/or jointly, SDCRAA and Ace Parking have infringed and continue to infringe at least claim 1 of the ’956 Patent through the use and operation of the Airport Parking System, which upon information and belief implements an INDECT Parking Guidance System (“INDECT PGS”) that meets and operates in accordance with the Airport’s “Parking Guidance System Requirements” (“PGSR”). A true and correct copy of the PGSR is attached as Exhibit D. On information and belief, this infringement has occurred and is occurring at least under 35 U.S.C. § 271(a) and/or (b).

15. On information and belief, either individually, and/or jointly, SDCRAA and Ace Parking, through agreements, contracts, agency, and/or joint enterprise, practiced each and every element of at least claim 1 of the ’956 Patent. Accordingly, SDCRAA and Ace Parking directly infringe the ’956 Patent under 35 U.S.C. § 271(a).

16. To the extent that some elements of a claim are performed by a different party than SDCRAA, such as Ace Parking, on information and belief, SDCRAA directs and controls the other party, such as Ace Parking, to jointly infringe the ’956 Patent including through a contractual relationship such that the infringing acts are attributable to both SDCRAA, who provides means to use the Airport Parking System, and Ace Parking, who operates and uses the Airport Parking System in a manner that infringes the ’956 Patent to receive contractual benefits from SDCRAA.

17. On information and belief, SDCRAA has contracted and entered into an agreement with Ace Parking to operate the Airport Parking System, and SDCRAA provides means to use and operate the Airport Parking System that infringes the ’956 Patent in this District.

18. On information and belief, SDCRAA directs and controls Ace Parking to operate and use the Airport Parking System in an infringing manner pursuant to a contractual agreement. On information and belief, Ace Parking receives benefits (e.g., contractual payments) from SDCRAA as a condition for Ace Parking's operation and infringing use of the Airport Parking System in the manner and timing dictated by SDCRAA pursuant to their contractual agreement.

19. On information and belief, SDCRAA has formed a joint enterprise with Ace Parking to operate and use the Airport Parking System in a manner that infringes the '956 Patent pursuant to a contractual relationship.

20. On information and belief, SDCRAA is alternatively liable pursuant to 35 U.S.C. § 271(b) for inducing and continuing to induce the direct infringement of Ace Parking. On further information and belief, Ace Parking directly infringes the method contained in claim 1 through SDCRAA's inducement, including providing means to use and operate the Airport Parking System pursuant to contractual obligations.

21. On information and belief, SDCRAA possessed a specific intent to induce infringement, by engaging in affirmative acts such as by (i) providing means to use and operate the Airport Parking System, and (ii) contracting with others and instructing others, such as Ace Parking, in connection with the infringement.

22. On information and belief, SDCRAA was aware of the '956 Patent, or willfully blind to the '956 patent.

23. On information and belief, SDCRAA possessed a specific intent to induce infringement, by engaging in affirmative acts such as by (i) setting forth requirements for the Airport Parking System in the PGSR, and (ii) on information and belief contracting for the purchase and installation of the INDECT PGS in use and operation in the Airport Parking System, which meets the PGSR and performs each and every element of at least claim 1 of the '956 Patent.

24. As a result of Defendants' infringement of the '956 Patent, upon

information and belief, Defendants' have made and will continue to make unlawful gains and profits.

25. Park Assist has been and will continue to be substantially and irreparably harmed by Defendants' infringement of the '956 Patent.

JURY DEMAND

26. Plaintiff hereby demands a jury on all issues so triable.

PRAYER FOR RELIEF

WHEREFORE, Park Assist prays for relief as follows:

A. A judgment that SDCRAA has infringed the Patent-in-Suit;

B. A judgment that Ace Parking has infringed the '956 Patent;

C. A judgment that the Defendants' liability is joint and several;

D. A judgment preliminarily and permanently enjoining and restraining SDCRAA, its officers, directors, agents, servants, employees, affiliates, subcontractors, including Ace, attorneys, and all others in active concert or participation with SDCRAA, from infringing the Patent-in-Suit, under 35 U.S.C. § 283;

E. A judgment awarding Park Assist its damages, but not less than a reasonable royalty, resulting from the Defendants' infringement, under 35 U.S.C. § 284;

F. A judgment awarding Park Assist its costs and disbursements incurred in prosecuting this action as authorized by Fed. R. Civ. P. 54, 28 U.S.C. § 1920, and/or 35 U.S.C. § 285;

G. A judgment awarding Park Assist its attorneys' fees incurred in prosecuting this action as authorized by 35 U.S.C. § 285 for an exceptional case;

H. A judgment awarding Park Assist pre- and post-judgment interest on any monetary award; and

Such other relief as the Court may deem just, equitable, and proper under the circumstances.

DATED: September 5, 2018

HIGGS FLETCHER & MACK LLP

By: */s/Mary R. Robberson*
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Attorneys for Plaintiff
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- and -

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US009594956B2

(12) **United States Patent**
Cohen et al.

(10) **Patent No.: US 9,594,956 B2**
(45) **Date of Patent: Mar. 14, 2017**

(54) **METHOD AND SYSTEM FOR MANAGING A PARKING LOT BASED ON INTELLIGENT IMAGING**

(75) Inventors: **Daniel Cohen**, Brooklyn, NY (US); **Richard Joffe**, New York, NY (US); **Bob Caspe**, Sherborn, MA (US); **Aaron Isaksen**, Brooklyn, NY (US); **Ilan Goodman**, New York, NY (US); **Ian Yamey**, New York, NY (US); **Michael Klevansky**, New York, NY (US); **Andrew Crawford**, Naas (IE); **Konstantyn Prokopenko**, Brooklyn, NY (US); **Steven Hartman**, Commack, NY (US); **Aurelien Ramondou**, New York, NY (US); **Mark Kudas**, Astoria, NY (US); **Ezequiel Cura**, New York, NY (US)

(73) Assignee: **PARK ASSIST LLC.**, New York, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 232 days.

(21) Appl. No.: **13/697,380**

(22) PCT Filed: **May 8, 2011**

(86) PCT No.: **PCT/IB2011/052024**

§ 371 (c)(1),
(2), (4) Date: **Jan. 13, 2013**

(87) PCT Pub. No.: **WO2011/141861**

PCT Pub. Date: **Nov. 17, 2011**

(65) **Prior Publication Data**

US 2013/0113936 A1 May 9, 2013

Related U.S. Application Data

(60) Provisional application No. 61/332,822, filed on May 10, 2010.

(51) **Int. Cl.**
G06K 9/00 (2006.01)
H04N 7/18 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G06K 9/00624*** (2013.01); ***G07B 15/02*** (2013.01); ***G08G 1/14*** (2013.01); ***H04N 7/18*** (2013.01)

(58) **Field of Classification Search**
CPC G08G 1/14; G06K 9/00624; H04N 7/18
(Continued)

(56) **References Cited**

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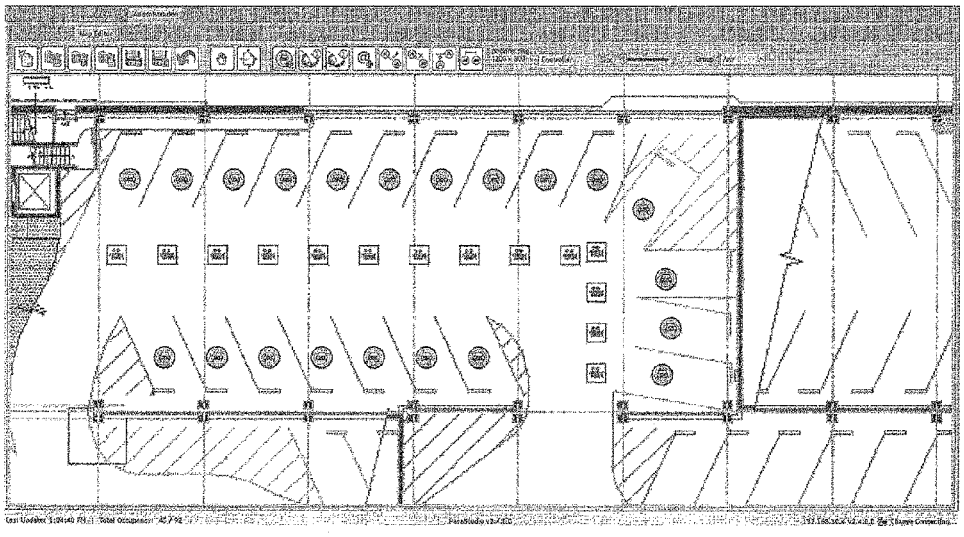
(Continued)

Primary Examiner — Christopher S Kelley
Assistant Examiner — Deirdre Beasley
(74) *Attorney, Agent, or Firm* — Mark M. Friedman

(57) **ABSTRACT**

To manage a plurality of parking spaces, one or more images are acquired, with each parking space appearing in at least one image. Periodically acquired images of occupancy and identity are used in directing a customer to a parked vehicle. Periodically acquired images of just occupancy are used in controlling respective environmental aspects, such as illumination and ventilation, of the parking spaces. For these purposes, the images are classified automatically as "vacant" or "occupied", and are displayed along with their classifications so that the classifications can be corrected manually.

2 Claims, 15 Drawing Sheets



(51) **Int. Cl.**
G07B 15/02 (2011.01)
G08G 1/14 (2006.01)

(58) **Field of Classification Search**
USPC 348/148; 340/932.2; 382/104
See application file for complete search history.

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* cited by examiner

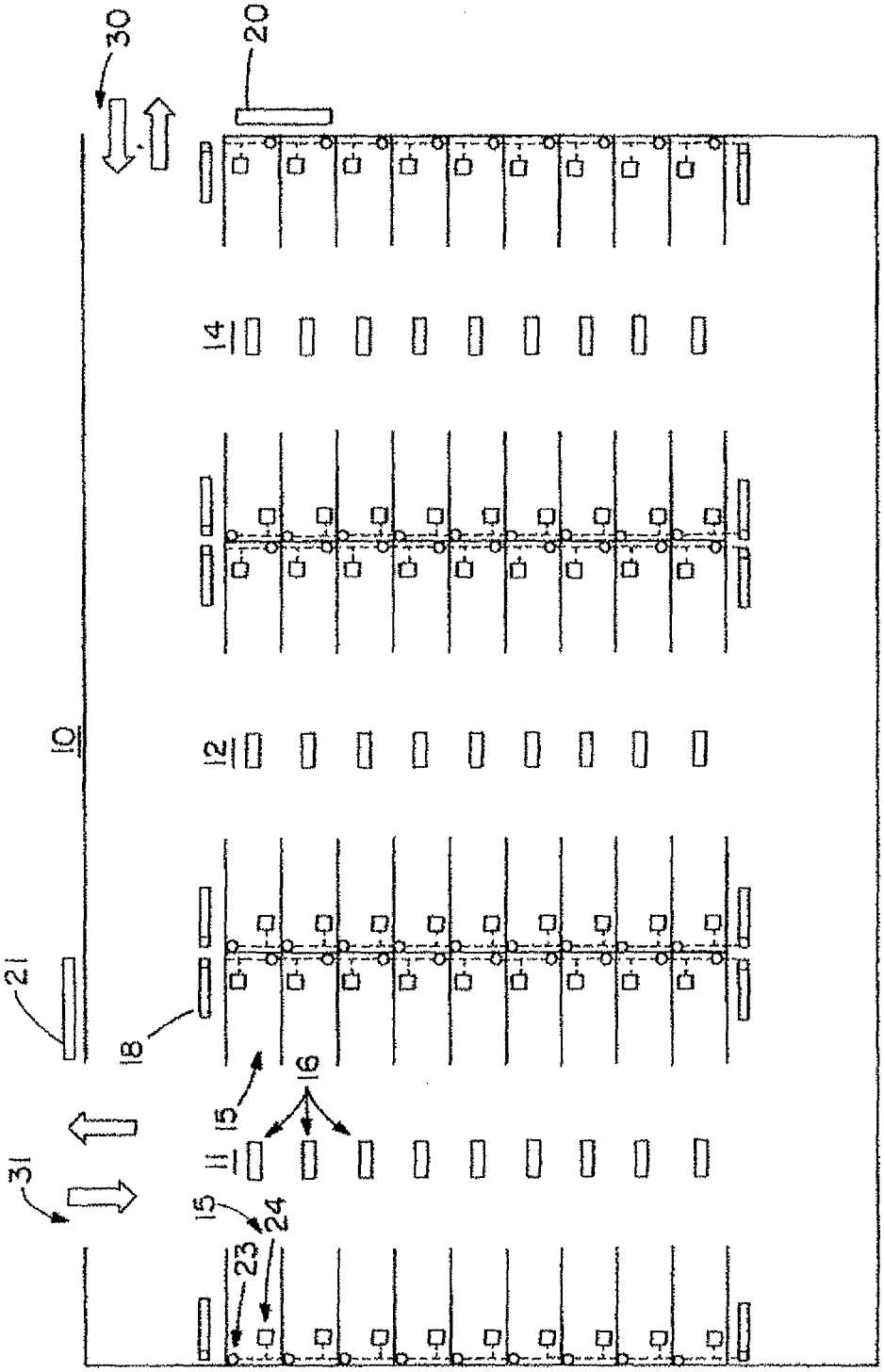


FIG. 1

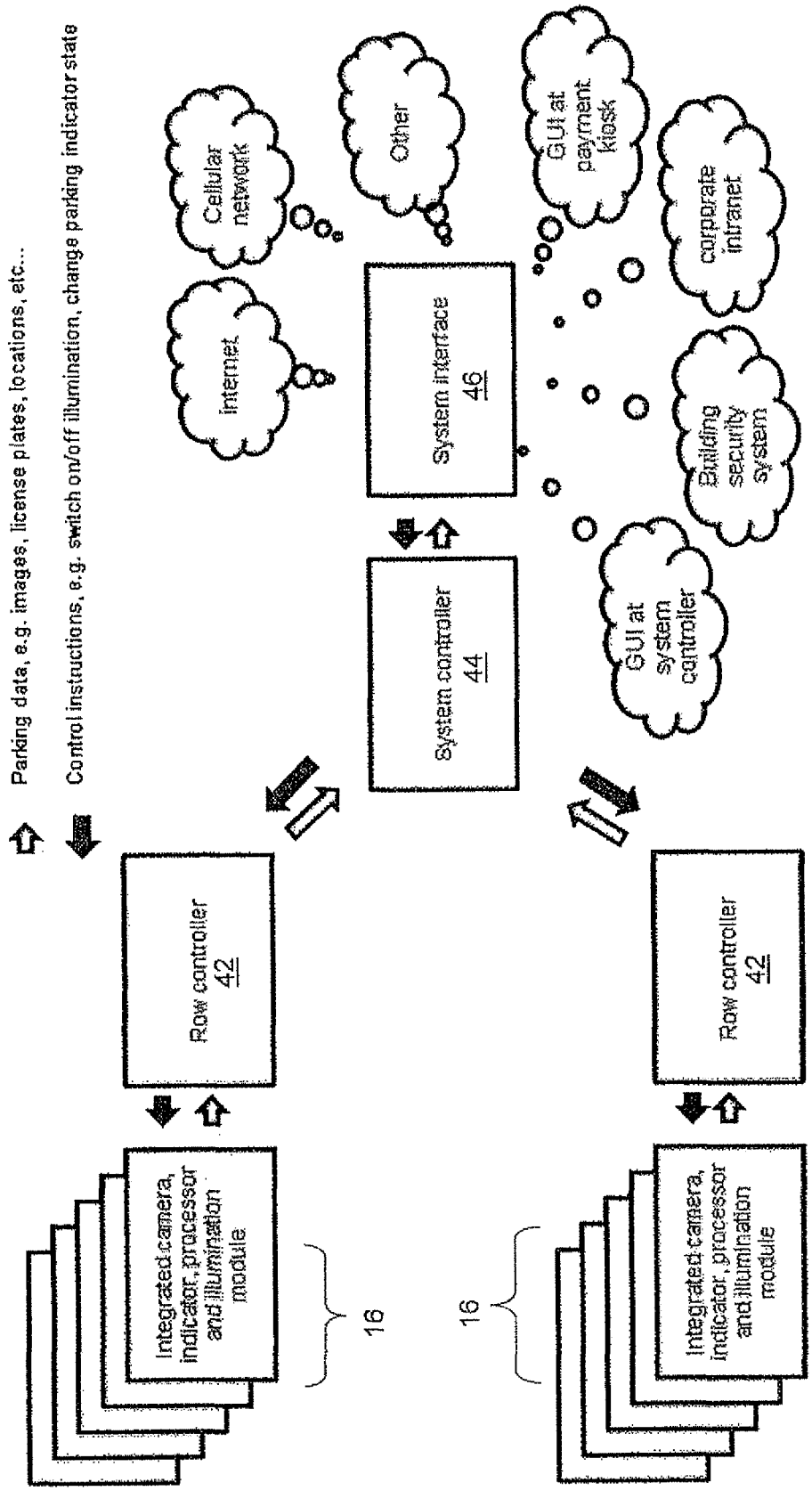

Parking data, e.g. images, license plates, locations, etc...
Control instructions, e.g. switch on/off illumination, change parking indicator state
Integrated camera, indicator, processor and illumination module
16
Row controller 42
System controller 44
System interface 46
Cellular network
Other
GUI at payment kiosk
corporate intranet
Internet
Building security system
GUI at system controller

FIGURE 2

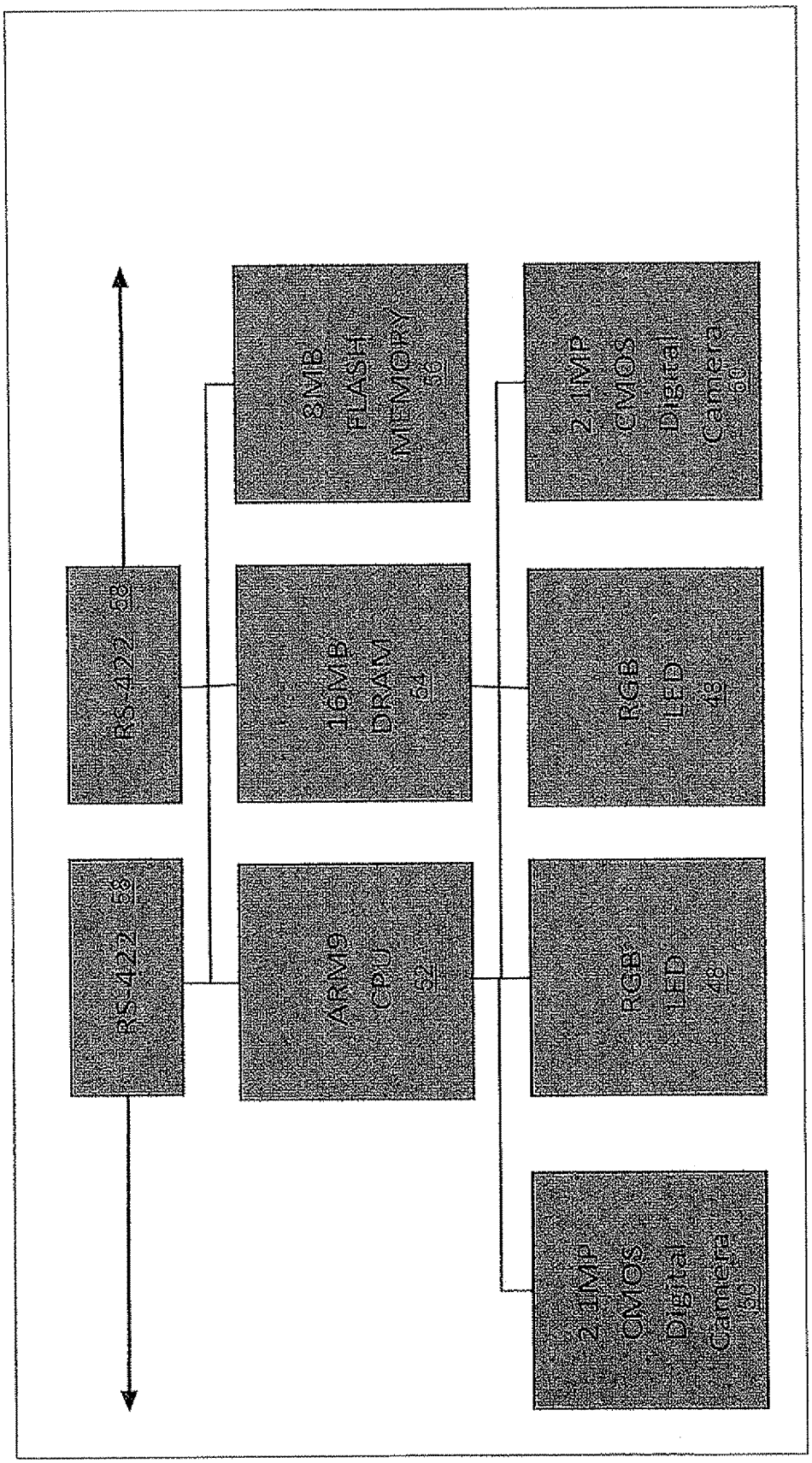

3 MB FLASH MEMORY 56
2.1MP CMOS Digital Camera 60
RS-422 58
16MB DRAM 54
RGB LED 48
RS-422 58
ARM9 CPU 52
RGB LED 48
2.1MP CMOS Digital Camera 60

FIGURE 3

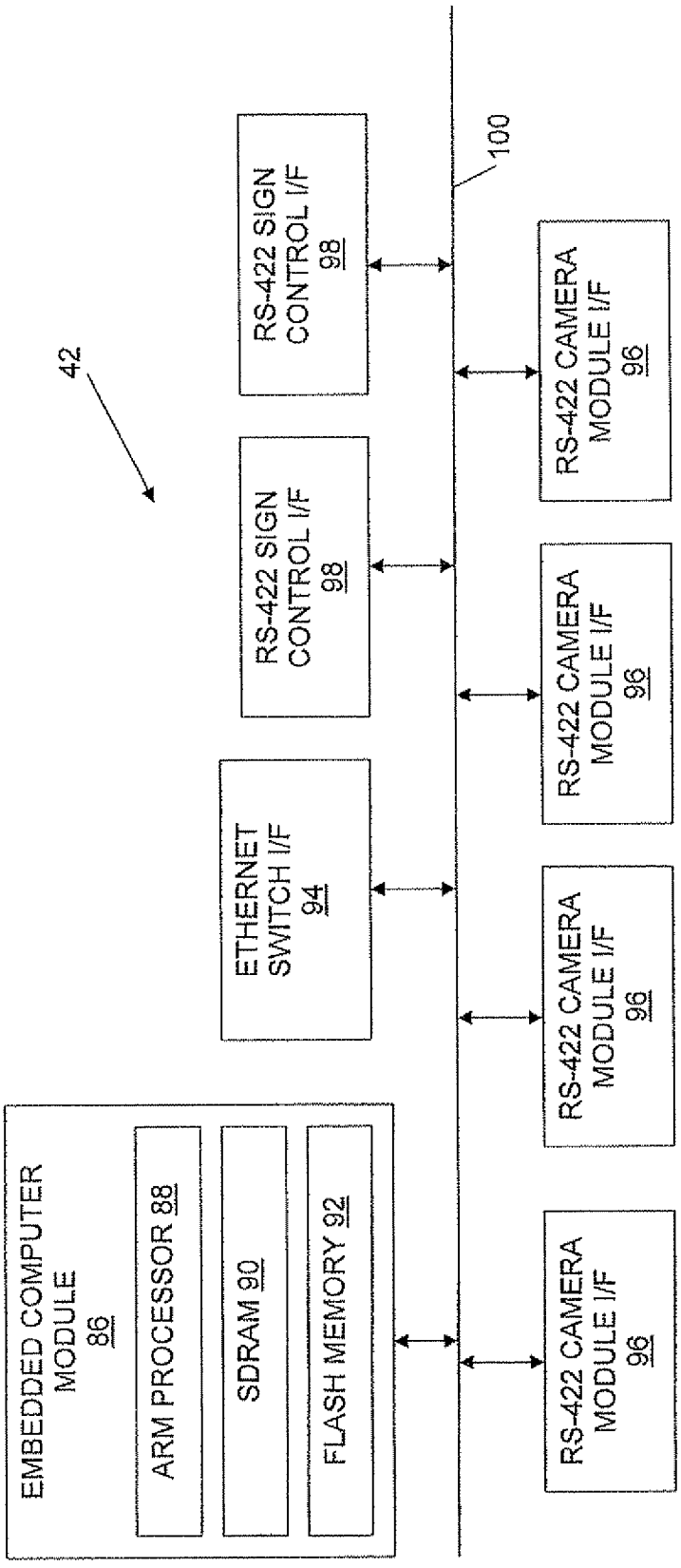
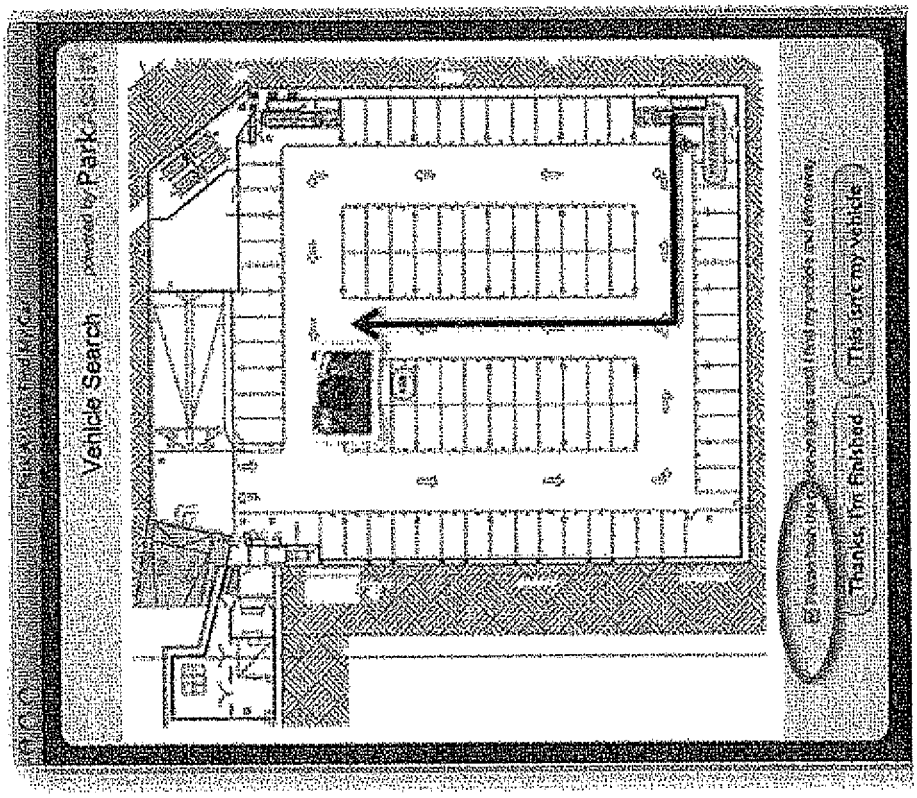

42
100
EMBEDDED COMPUTER MODULE 86
ARM PROCESSOR 88
SDRAM 90
FLASH MEMORY 92
ETHERNET SWITCH I/F 94
RS-422 SIGN CONTROL I/F 98
RS-422 SIGN CONTROL I/F 98
RS-422 CAMERA MODULE I/F 96
RS-422 CAMERA MODULE I/F 96
RS-422 CAMERA MODULE I/F 96
RS-422 CAMERA MODULE I/F 96

FIGURE 4


Vehicle Search
Thanks, I'm Finished
This is my Vehicle


Vehicle Search
Search
This is my car, show me the map!

FIGURE 5

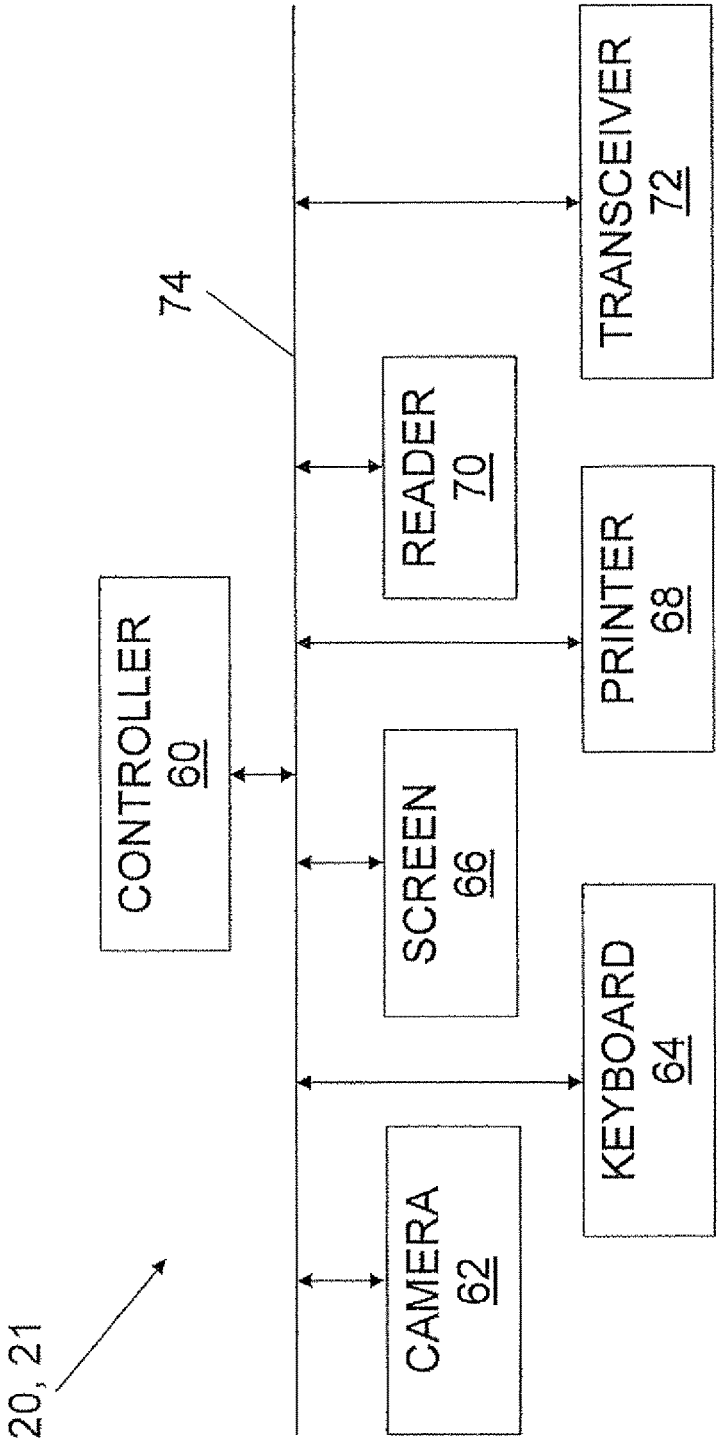

20, 21
74
CONTROLLER 60
CAMERA 62
SCREEN 66
READER 70
KEYBOARD 64
PRINTER 68
TRANSCEIVER 72

FIGURE 6

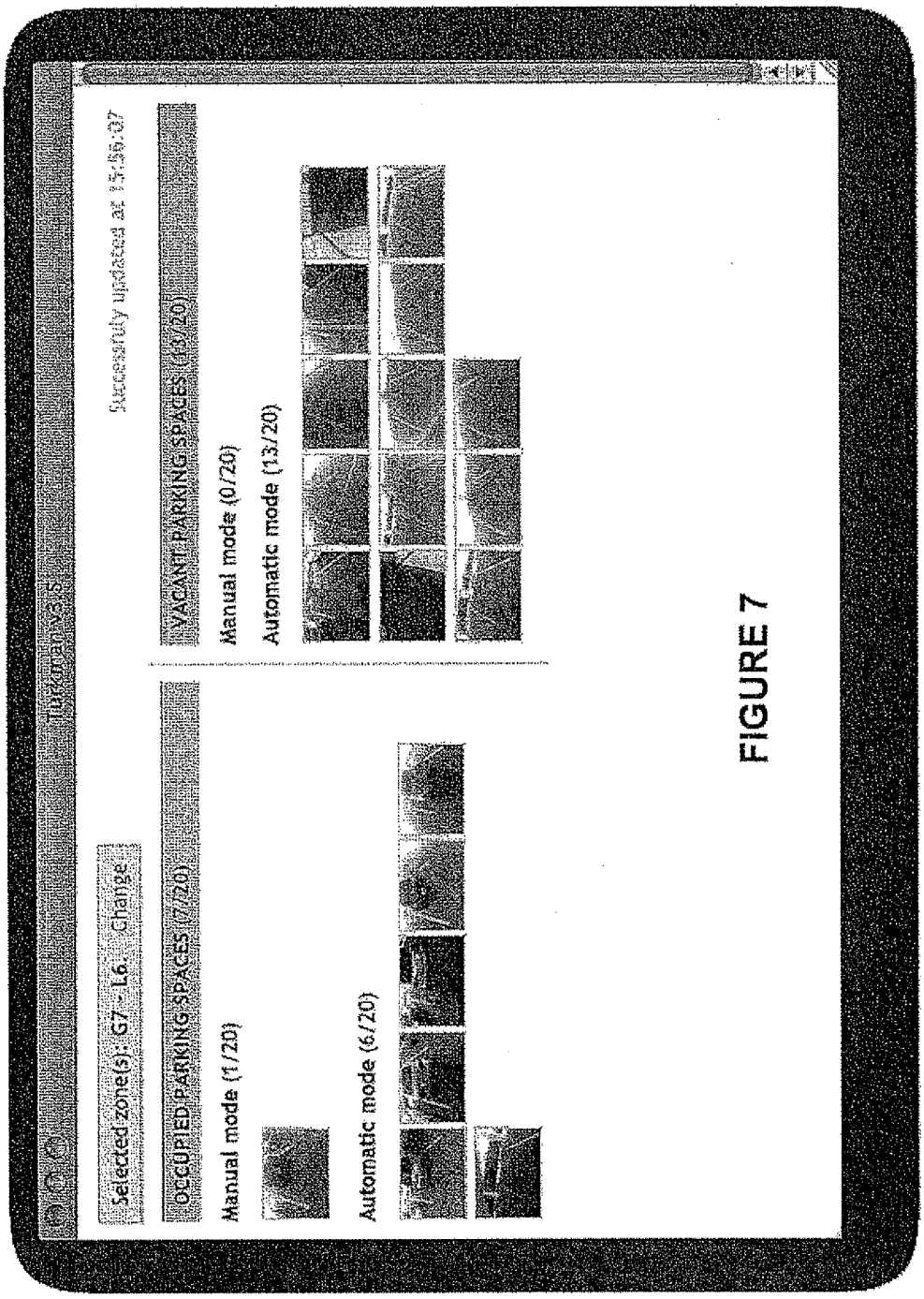

Selected zone(s): G7 - L6 Change
Successfully updated at 15:56:07
OCCUPIED PARKING SPACES (7/20)
Manual mode (1/20)
Automatic mode (6/20)
VACANT PARKING SPACES (13/20)
Manual mode (0/20)
Automatic mode (13/20)

FIGURE 7

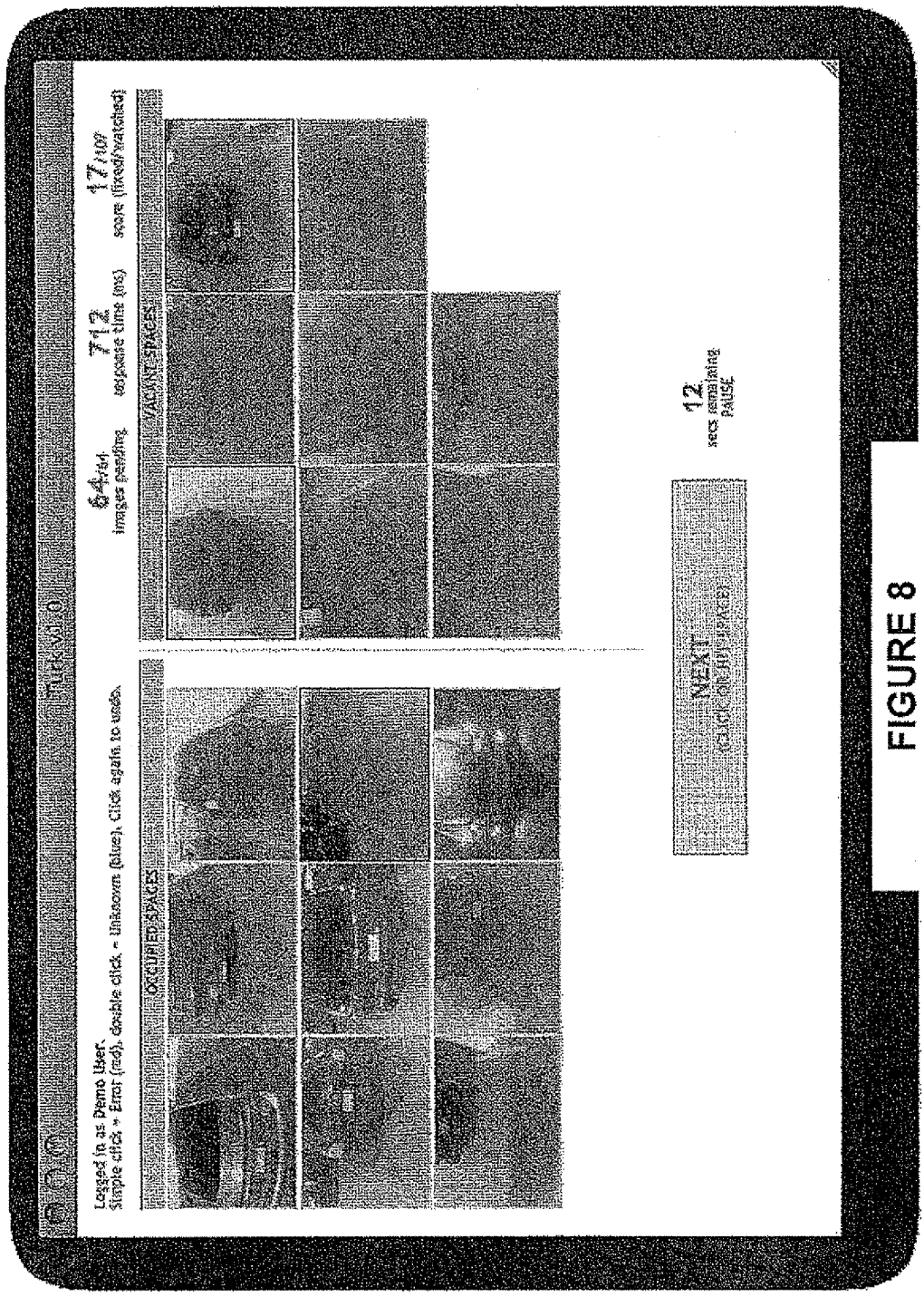

Turk v1.0
Logged in as Demo User.
Simple click = Error (red), double click = Unknown (blue). Click again to undo.
OCCUPIED SPACES
64/64
images pending
712
response time (ms)
17/107
score (fixed/attached)
VACANT SPACES
12
secs remaining
PAUSE
NEXT

FIGURE 8

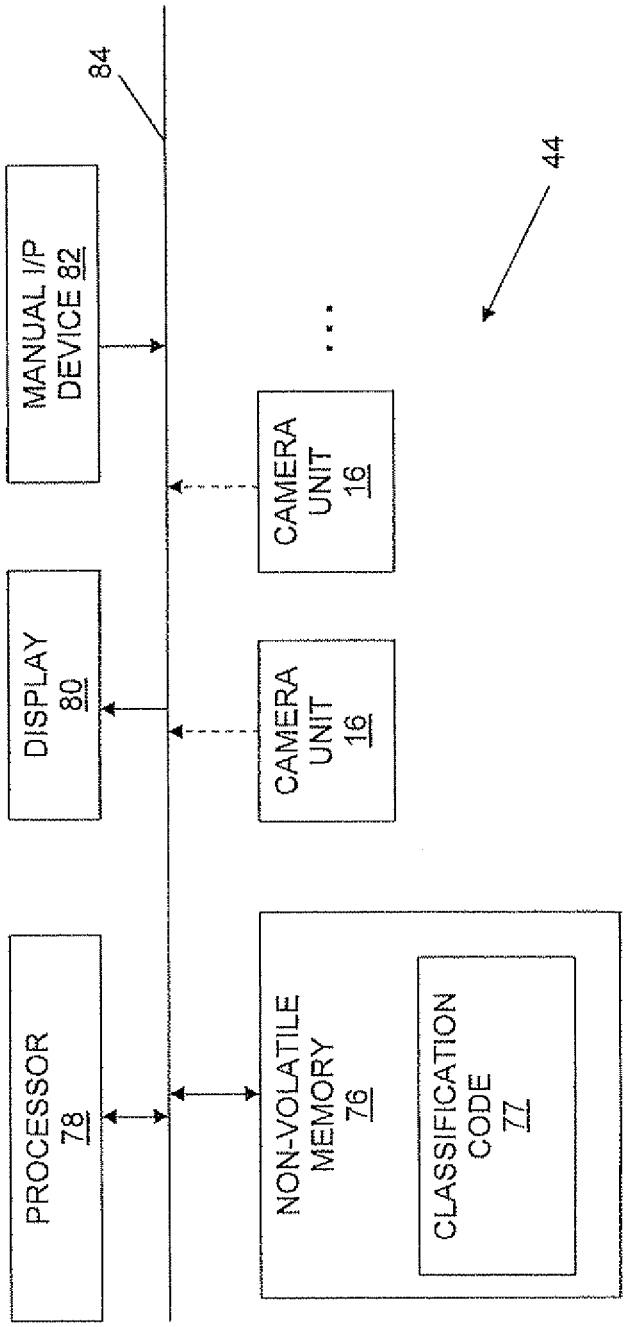

84
44
MANUAL I/P DEVICE 82
DISPLAY 80
PROCESSOR 78
CAMERA UNIT 16
CAMERA UNIT 16
NON-VOLATILE MEMORY 76
CLASSIFICATION CODE 77

FIGURE 9

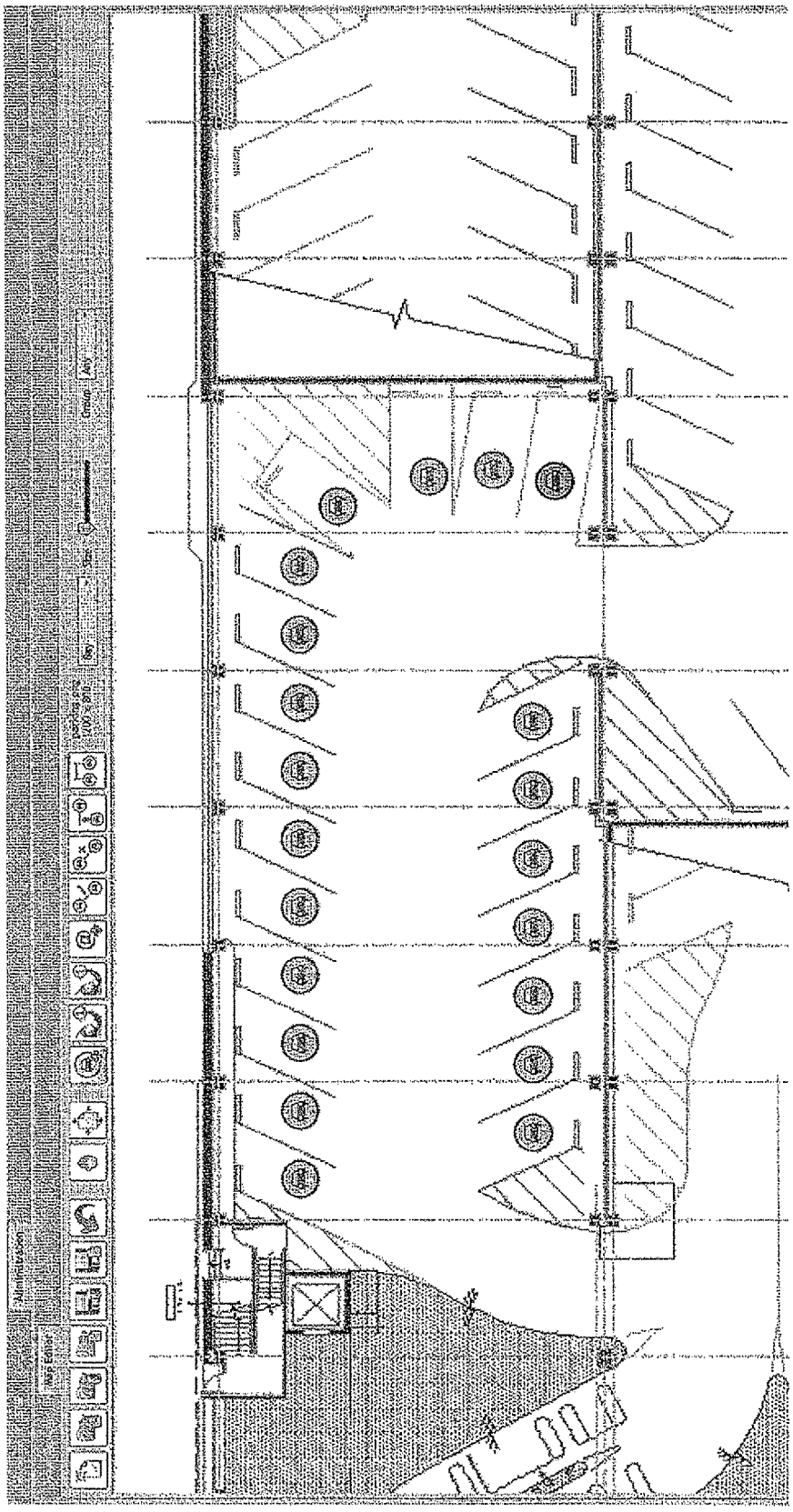


FIGURE 10A

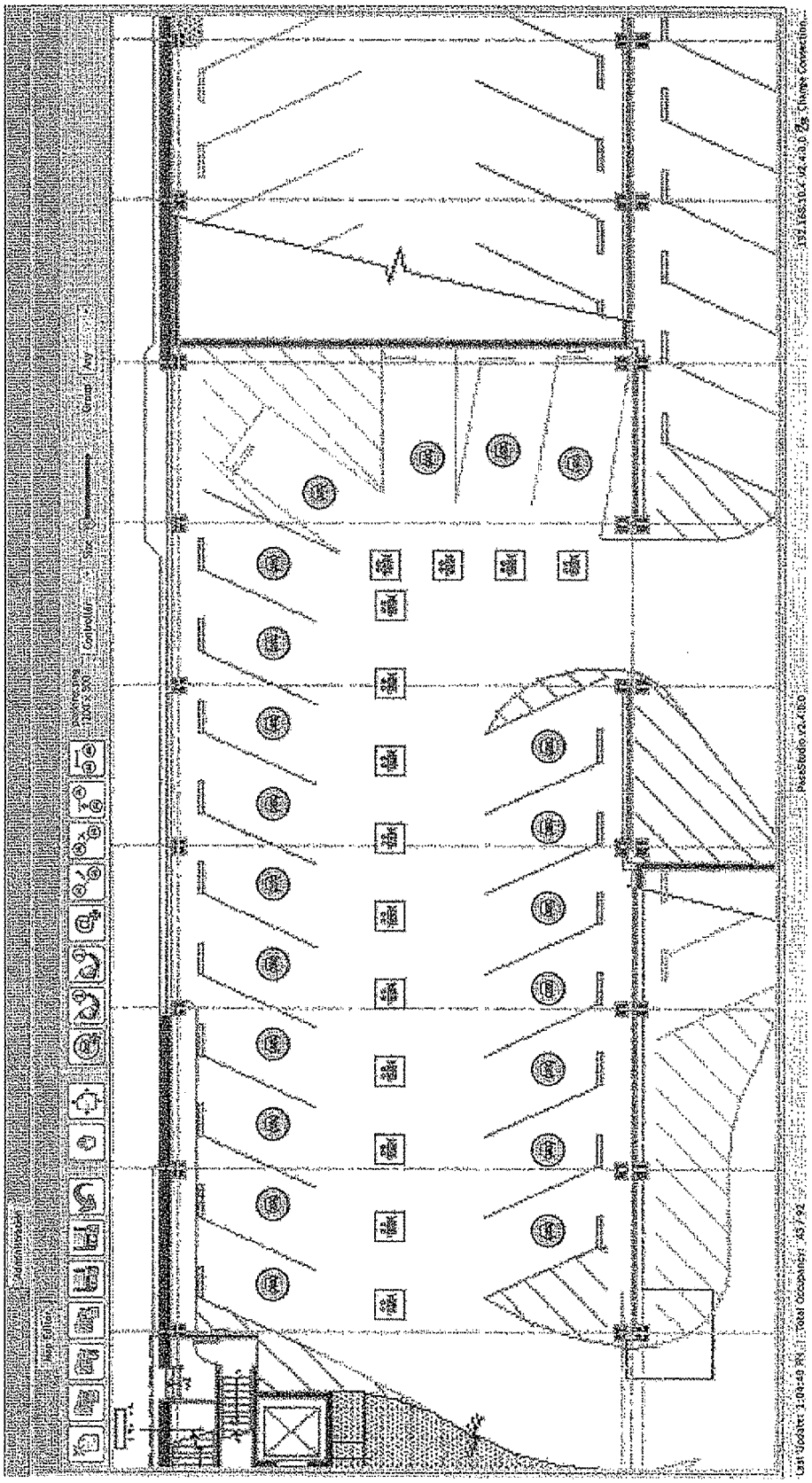


FIGURE 10B

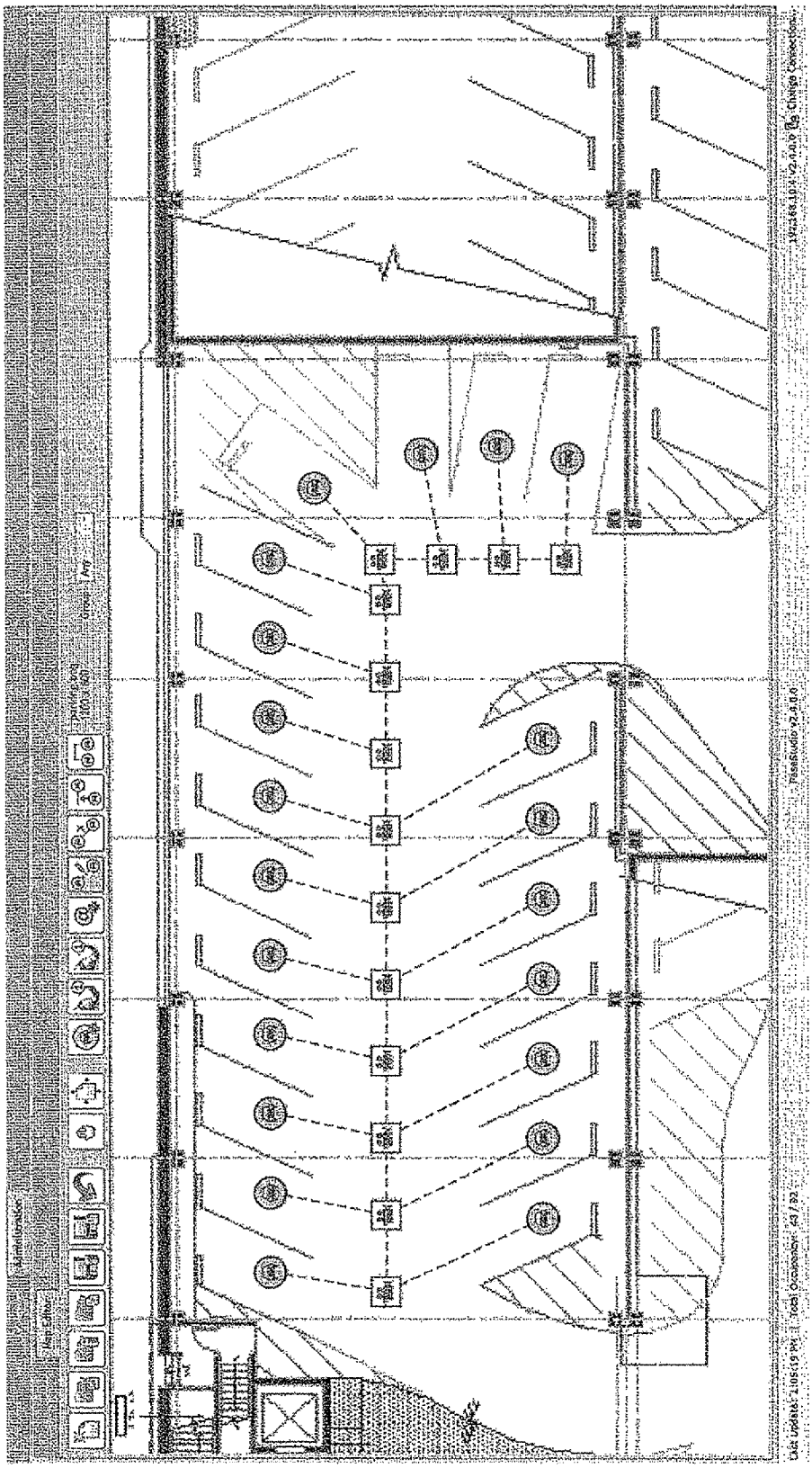


FIGURE 10C

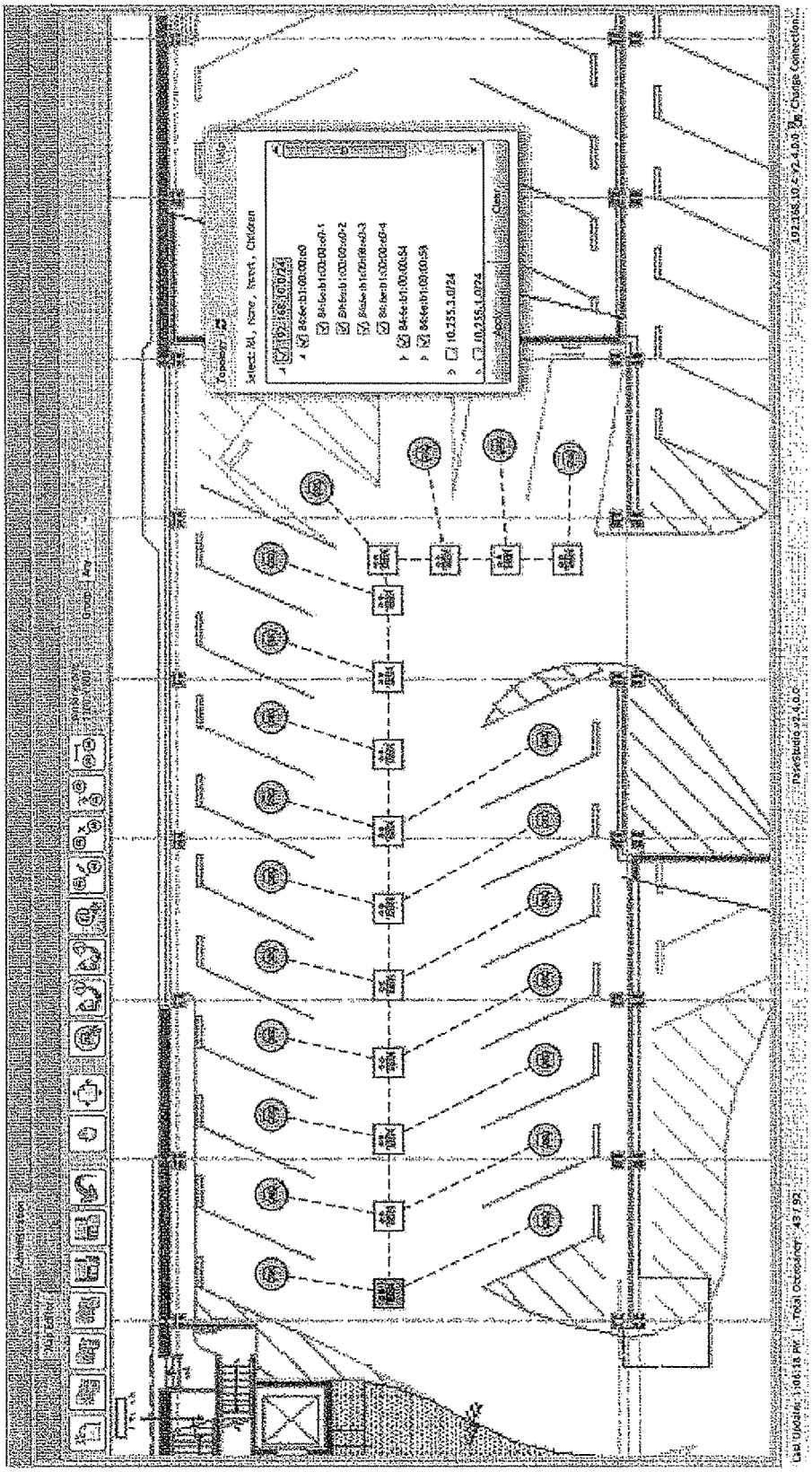
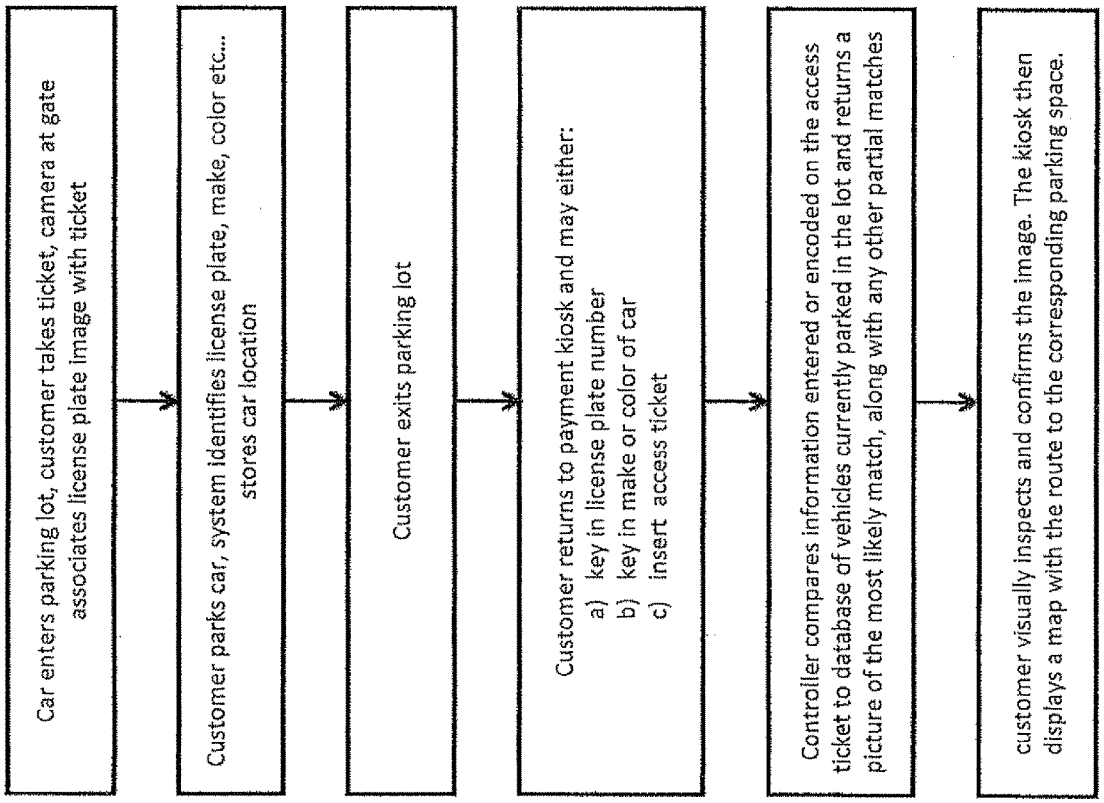


FIGURE 10D

FIGURE 11


Car enters parking lot, customer takes ticket, camera at gate associates license plate image with ticket
Customer parks car, system identifies license plate, make, color etc... stores car location
Customer exits parking lot
Customer returns to payment kiosk and may either:
a) key in license plate number
b) key in make or color of car
c) insert access ticket
Controller compares information entered or encoded on the access ticket to database of vehicles currently parked in the lot and returns a picture of the most likely match, along with any other partial matches
customer visually inspects and confirms the image. The kiosk then displays a map with the route to the corresponding parking space.

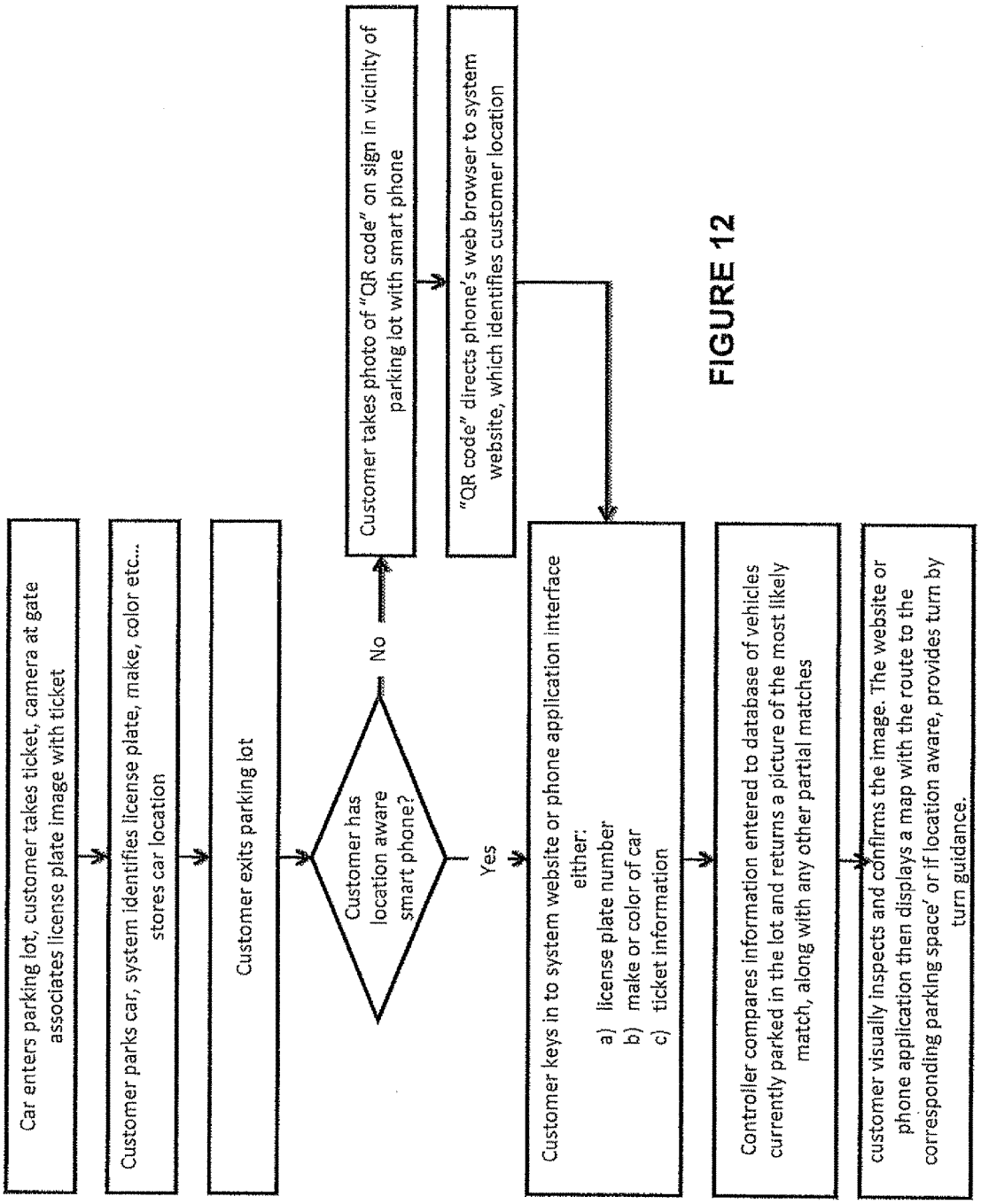

Car enters parking lot, customer takes ticket, camera at gate associates license plate image with ticket
Customer parks car, system identifies license plate, make, color etc... stores car location
Customer exits parking lot
Customer has location aware smart phone?
No
Customer takes photo of "QR code" on sign in vicinity of parking lot with smart phone
"QR code" directs phone's web browser to system website, which identifies customer location
Yes
Customer keys in to system website or phone application interface either:
a) license plate number
b) make or color of car
c) ticket information
Controller compares information entered to database of vehicles currently parked in the lot and returns a picture of the most likely match, along with any other partial matches
customer visually inspects and confirms the image. The website or phone application then displays a map with the route to the corresponding parking space' or if location aware, provides turn by turn guidance.

FIGURE 12

METHOD AND SYSTEM FOR MANAGING A PARKING LOT BASED ON INTELLIGENT IMAGING

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to the management of a parking lot and, more particularly, to setting up and using a parking lot managing system that relies on intelligent processing of images of the various parking spaces.

A number of methods have been proposed in the past in order to provide customers guidance within a parking lot to quickly find available space. The use of different sensor technologies, such as ultrasonics or image processing is known. These methods may determine occupancy of slots and provide the driver with guidance to available spaces either upon entry to the parking lot or by displays strategically located within the lot. See for example Trajkovic et al., U.S. Pat. No. 6,426,708, which patent is incorporated by reference for all purposes as if fully set forth herein. However, these methods do not provide customers with guidance to find their car when leaving the parking lot. They do not allow the parking lot proprietor the opportunity to preferentially charge the customer according their parking location within the parking lot. Furthermore, these systems do not integrate the parking lot illumination system with the parking control system so as to enable illumination levels or ventilation systems to be controlled based on parking occupancy, reducing energy consumption. In addition, they do not detect the type of object that is stored in the space, determining if it is a car, motorcycle, parking cart, or other object. They also do not recognize unique aspects of the vehicle, such as make, model, color, and license plate, and thus do not allow the opportunity to present targeted advertisements or marketing programs based on such information. They also do not enable remote viewing of individual parking spaces, enabling human intervention to correct mistakes, detect faulty hardware, or provide real-time feedback to improve system accuracy. Finally, they are not integrated with closed circuit security systems, nor do they offer any information about vehicle and passenger security, such as thefts and violent attacks.

DEFINITIONS

An "occupancy and identity image" is understood herein to mean an image from which either a human operator or a computer equipped with appropriate image processing software can decide whether a parking space is occupied and also can determine the identity of a vehicle that occupies an occupied parking space. A typical example of such an image is an image from which a license plate detection algorithm can extract a license plate number.

An "occupancy image" is understood herein to mean an image from which either a human operator or a computer equipped with appropriate image processing software can decide whether a parking space is occupied.

An "identification image" is understood herein to mean an image from which either a human operator or a computer equipped with appropriate image processing software can determine the identity of a vehicle given that the image is known to be an image of a vehicle.

The images may be acquired in any convenient wavelength band: infrared, visible or ultraviolet. Usually, the images are RGB images at visible wavelengths.

SUMMARY OF THE INVENTION

One objective of the present invention is to provide guidance to customers to efficiently find available parking in a parking lot. A second objective of the present invention is to provide customers guidance in finding their car within a parking lot. A third objective of the present invention is to enable preferential pricing for parking based on location within the parking lot. A fourth objective of the present invention is to reduce parking lot energy consumption. A fifth objective of the present invention is to improve parking lot security. A sixth objective of the present invention is to determine the type of object or vehicle that is currently parked in the parking space, to determine if it is a car, motorcycle, person, parking cart, or other object. A seventh objective of the present invention is to improve enforcement of parking lot rules and regulations. An eighth objective of the present invention is to administer targeted advertising and loyalty programs through vehicle identification. A ninth objective of the present invention is to automatically discover the network topology to enable efficient mapping of the sensor locations onto a map of the parking lot, enabling all services already mentioned to be location-based. A tenth objective of the present invention is to provide a platform for real-time remote monitoring and human control of the parking system.

Therefore, according to the present invention there is provided a method of managing a plurality of parking spaces, including: (a) acquiring at least one occupancy and identity image, such that each parking space is imaged in at least one the occupancy and identity image; and (b) in response to an inquiry by a customer who has parked a vehicle in one of the parking spaces, directing the customer to the vehicle, at least in part in accordance with the at least one occupancy and identity image in which the parking space in which the vehicle is parked is imaged.

Furthermore, according to the present invention there is provided a system for managing a plurality of parking spaces, including: (a) at least one parking space camera for acquiring at least one occupancy and identity image, such that each parking space is imaged in at least one the occupancy and identity image; and (b) a controller that, in response to an inquiry by a customer who has parked a vehicle in one of the parking spaces, directs the customer to the vehicle, at least in part in accordance with the at least one occupancy and identity image in which the parking space in which the vehicle is parked is imaged.

Furthermore, according to the present invention there is provided a method of managing a plurality of parking spaces, including: (a) acquiring at least one occupancy image, such that each parking space is imaged in at least one the occupancy image; and (b) controlling at least one respective environmental aspect of the parking spaces at least in part in accordance with the at least one occupancy image.

Furthermore, according to the present invention there is provided a system for managing a plurality of parking spaces, including: (a) at least one camera for acquiring at least one occupancy image, such that each parking space is imaged in at least one the occupancy image; (b) for each of at least one environmental aspect of the parking spaces, a plurality of devices for controlling the each environmental aspect; and (c) a controller that uses the devices to controls the at least one environmental aspect at least in part in accordance with the at least one occupancy image.

Furthermore, according to the present invention there is provided a method of managing a plurality of parking

spaces, including: (a) acquiring a respective occupancy image of each parking space; (b) providing a system that assigns each occupancy image a respective status selected from the group consisting of vacant and occupied; (c) displaying the occupancy images along with the statuses thereof; and (d) in response to the displaying: for each occupancy image: (i) deciding whether the respective status of the each occupancy image is incorrect, and (ii) if the respective status of the each occupancy image is incorrect, correcting the respective status of the each occupancy image.

Furthermore, according to the present invention there is provided a system for managing a plurality of parking spaces, including: (a) at least one camera for acquiring a respective occupancy image of each parking space; (b) a display device for displaying at least a portion of the occupancy images; (e) a memory for storing program code for: (i) assigning each occupancy image a respective status selected from the group consisting of vacant and occupied, and (ii) displaying the occupancy images on the display device along with the respective assigned statuses thereof; (d) a processor for executing the program code; and (e) an input device for correcting the respective assigned statuses as displayed on the display device.

Furthermore, according to the present invention there is provided a computer-readable storage medium having computer-readable code embodied on the computer-readable storage medium, the computer-readable code for managing a plurality of parking spaces, the computer-readable code including: (a) program code for assigning to each of a plurality of respective occupancy images of the parking spaces a respective status selected from the group consisting of vacant and occupied; (b) program code for displaying the occupancy images along with the respective assigned statuses thereof; and (c) program code for receiving corrections of the respective assigned statuses.

Furthermore, according to the present invention there is provided a method of configuring a plurality of sensors to monitor parking spaces of a plurality of aisles, each aisle including a respective plurality of the parking spaces, the method including: (a) for each aisle: (i) providing a respective sub-plurality of the sensors for monitoring the parking spaces of the each aisle, each sensor being for monitoring a respective at least one of the parking spaces of the each aisle, and (ii) operationally connecting the sensors of the respective sub-plurality to each other in an ordered string, such that a first sensor of the string is a root node of the string; (b) operationally connecting the root nodes to a central controller, thereby providing a network of the sensors; (c) by the central controller: discovering a topology of the network; and (d) for each string: (i) mapping only one sensor of the string to the respective at least one parking space that the one sensor is to monitor, and (ii) using the topology to map each other sensor of the respective string to the respective at least one parking space that the each other sensor is to monitor.

Furthermore, according to the present invention there is provided a system for monitoring parking spaces of a plurality of aisles, each aisle including a respective plurality of the parking spaces, the system including: (a) for each aisle, a respective plurality of sensors operationally connected to each other in an ordered string, the sensors being for monitoring a respective at least one of the parking spaces of the each aisle, with a first the sensor of the string being a root node of the string; and (b) a controller to which the root nodes are operationally connected so that the controller and the strings form a network, the controller being operative: (i) to discover a topology of the network, (ii) to present a user interface for mapping only one sensor of each string to the respective at least one parking space that the one sensor is to monitor, and (iii) for each string, to use the topology to map each sensor of the each string other than the only one sensor of the each string to the respective at least one parking space that the each sensor is to monitor.

Furthermore, according to the present invention there is provided a computer-readable storage medium having computer-readable code embodied on the computer-readable storage medium, the computer-readable code being for configuring a plurality of sensors to monitor parking spaces of a plurality of aisles, each aisle including a respective plurality of the parking spaces, the sensors of each aisle being operationally connected to each other in an ordered string with a first sensor of the string being a root node of the string, the root nodes being operationally connected to a controller so that the controller and the strings form a network, the computer-readable code including: (a) program code for discovering a topology of the network; (b) program code for presenting a user interface for mapping only one sensor of each string to the respective at least one parking space that the one sensor is to monitor; and (c) program code for, for each string, using the topology to map each sensor of the each string other than the only one sensor of the each string to the respective at least one parking space that the each sensor is to monitor.

The methods of the present invention are methods of managing a plurality of parking spaces.

According to a first basic method, one or more occupancy and identity images of the parking spaces are acquired, with each parking space being imaged in at least one of the occupancy and identity images. In response to an inquiry by a customer who has parked a vehicle in one of the parking spaces, the customer is directed to the vehicle, at least in part in accordance with the occupancy and identity image(s) in which the parking space occupied by the vehicle is/are imaged.

Preferably, the occupancy and identity image(s) is/are acquired periodically.

Preferably, the method also includes obtaining an identifier of the vehicle, either before the vehicle is parked or as a part of the inquiry. Examples of such identifiers include license plate numbers and partial or complete visual characterizations such as make and color. One example of an inquiry that provides a vehicle identifier is a typed inquiry that includes the license plate number of the vehicle. The parking space in which the vehicle is parked then is identified, in response to the inquiry, at least in part by comparing the identifier to the occupancy and identity image(s) in which the parking space occupied by the vehicle is/are imaged.

If the identifier of the vehicle is obtained before the vehicle is parked, then the obtaining of the identifier of the vehicle includes acquiring an identification image of the vehicle. Most preferably, the method then includes issuing to the customer a receipt, such as a printed access ticket or a packet that is transmitted wirelessly to a mobile device of the customer, before the customer parks the vehicle. The receipt includes a representation of the identifier.

Preferred modes of directing the customer to the vehicle include displaying a map that shows a route to where the vehicle is parked or issuing navigation instructions, as a printed list or as interactive instructions transmitted wirelessly to a mobile device borne by the customer.

A system for implementing the first basic method includes at least one parking space camera (e.g. cameras **50** in the preferred embodiments described below) and a controller.

The parking space camera(s) is/are for acquiring the occupancy and identity image(s). The controller, in response to the customer's inquiry, directs the customer to the vehicle at least in part in accordance with the occupancy and identity image(s) in which the parking space occupied by the vehicle is/are imaged. Preferably, the system includes a plurality of such parking space cameras, with each parking space camera acquiring respective one or more occupancy and identity images of one or more respective parking spaces. Usually, each parking space camera is dedicated to one, two or four specific respective parking spaces.

Preferably, the system also includes an information terminal at which the customer enters the query. Most preferably, the information terminal includes a display mechanism for displaying instructions that direct the customer to the vehicle. Examples of such display mechanisms include a display screen for displaying a map with directions to the parking space, a printer for printing such a map or for printing a list of navigation instructions, and a transceiver for transmitting such instructions interactively to a mobile device borne by the customer as the customer walks to the parking space. Most preferably, the information terminal also includes an input mechanism that the customer uses to input an identifier of the vehicle. A typical example of such an input mechanism is a keyboard at which the customer types the license plate number of the vehicle. In response to the inquiry, the controller identifies the parking space, in which the vehicle is parked, at least in part by comparing the identifier to (one or more of) the occupancy and identity image(s).

Alternatively or additionally, the system also includes a gateway terminal for obtaining an identifier of the vehicle before the customer parks the vehicle in the parking space. In response to the inquiry, the controller identifies the parking space, in which the vehicle is parked, at least in part by comparing the identifier to (one or more of) the occupancy and identity image(s). Most preferably, the gateway terminal includes a mechanism for issuing to the customer a receipt such as an access ticket that includes a representation of the identifier. Also most preferably, the gateway terminal includes an identification camera for acquiring an identification image of the vehicle.

In the preferred embodiments below, entry kiosks **20** and **21** serve both as information terminals and gateway terminals.

According to a second basic method, one or more occupancy images of the parking spaces are acquired, preferably periodically, with each parking space being imaged in at least one of the occupancy images. One or more respective environmental aspects of the parking spaces are controlled at least in part in accordance with the occupancy image(s). Typically, the environmental aspect(s) that is/are controlled is/are illumination and/or ventilation. A corresponding system includes one or more cameras for acquiring the occupancy image(s), a plurality of devices per environmental aspect for controlling the environmental aspect, and a controller that uses the devices to control the environmental aspect(s) at least in part according to the occupancy image(s).

A third basic method starts with acquiring respective occupancy images of the parking spaces. An image classification system automatically designates each occupancy image either "vacant" or "occupied". The occupancy images are displayed along with their "vacant/occupied" statuses. In response to the display, a human operator decides whether the classifications are correct and corrects the incorrect classifications. Preferably, the image classification system uses a self-modifying classification algorithm, i.e., an algorithm that can be trained to improve the classification accuracy thereof. In response to the corrections by the human operator, the classification system modifies the classification algorithm to be more accurate.

A corresponding system includes one or more cameras for acquiring the occupancy images, a display device for displaying the occupancy images, a memory for storing program code for classifying the occupancy images as either "vacant" or "occupied" and for displaying the occupancy images along with their respective "vacant/occupied" classifications, a processor for executing the code, and an input device that a human operator uses to correct the classifications as displayed on the display device. Preferably, the algorithm that the program code uses to classify the occupancy images is self-modifying. The scope of the invention also includes a computer-readable storage medium bearing such computer-readable program code.

A fourth basic method of the present invention is a method of configuring a plurality of sensors, such as camera units **16** of FIG. **1** below, to monitor parking spaces of a plurality of aisles, such as aisles **11**, **12** and **14** of FIG. **1** below, each of which includes its own respective plurality of parking spaces. Each aisle is provided with two or more sensors. It is intended that each sensor be responsible for monitoring one or more respective parking spaces of the aisle. In each aisle, the sensors are connected operationally to each other in an ordered string. (That the string is ordered means that, with $N \geq 2$ sensors in the string, the first sensor is connected only to the second sensor, the; last sensor is connected only to the next-to-last sensor, and, if $N>2$, sensor i ($1<i<N$)) is connected only to sensors i−1 and i+1.) The first camera in each string is the root node of the string. All the root nodes are connected operationally to a central controller such as system controller **44** of the preferred embodiments described below, either directly or indirectly via intermediate devices such as row controllers **42** of the preferred embodiments described below, thereby providing a network of the sensors. The central controller discovers the topology of the network. Only one sensor of each string (preferably the root node sensor) is mapped to the respective parking space(s) that that sensor is to monitor. The topology is used to map the other sensors of each string to their respective parking spaces.

A corresponding system includes, for each aisle, a respective plurality of sensors operationally connected to each other in an ordered string with a first sensor of the string being a root node of the string, and a controller to which all the root nodes are operationally connected, so that the controller and the strings form a network. The controller is operative to discover the topology of the network, to present a user interface for mapping only one sensor of each string to its respective parking space(s), and to use the topology to map the rest of the sensors to their respective parking spaces. The scope of the invention also includes a computer-readable storage medium bearing computer-readable program code that the controller executes to accomplish those ends.

The controllers of the systems of the present invention may be local to the parking lot that includes the managed parking spaces or, as illustrated in FIG. **2** below, may be distributed among two or more sites with the various components of the controllers communicating with each other via a network such as the Internet.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments are herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. **1** is a plan view of a parking lot;

FIG. **2** is a schematic illustration of a system of the present invention;

FIG. **3** is a block diagram of a camera unit of FIG. **2**;

FIG. **4** is a block diagram of a row controller of FIG. **2**;

FIG. **5** shows screen captures that illustrate the "find your car" feature;

FIG. **6** is a partial block diagram of an entry kiosk of FIG. **1**;

FIGS. **7** and **8** shows web page user interfaces for manual tuning of the automatic vehicle detection algorithm;

FIG. **9** is a partial block diagram of a system controller that is configured to support interactive correction of automatic occupancy detection;

FIGS. **10**A-**10**D illustrate mapping of camera units to their locations following camera unit network topology discovery;

FIGS. **11** and **12** are flowcharts of the "find your car" feature.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The principles and operation of a parking lot according to the present invention may be better understood with reference to the drawings and the accompanying description.

Referring now to the drawings, FIG. **1** is a plan view of the interior of an exemplary enclosed parking lot **10** that is managed according to the principles of the present invention. Parking lot **10** includes three aisles **11**, **12** and **14**, each aisle including two rows of parking spaces **15**. Each pair of parking spaces is monitored by an associated camera unit **16**. Each parking space **15** is provided with its own ventilation vent **23** and its own lighting fixture **24**, in the ceiling of parking lot **10**. Each row of parking spaces **15** has two row displays **18** at either end. Each entrance **30**, **31** of parking lot **10** has adjacent to it an entry kiosk **20**, **21**.

FIG. **2** illustrates an exemplary embodiment of a system of the current invention. The system includes camera units **16**, row controllers **42**, a system controller **44** and a system user interface **46**. System user interface **46** may be connected to multiple additional external systems as shown in FIG. **2**.

In one embodiment of the system of FIG. **2**, high resolution, low noise, CMOS digital camera technology is used for the purpose of monitoring every parking space **15**. Images that are collected are processed within the individual camera module **16**. Images, license plate data or occupancy data or any combination of the three can be passed through row controllers **42** to the central system controller **44** for actual live inspection down to the individual space **15** from the central station.

Remote access to the central station through the Internet can provide control and access including live images from any of up to thousands of cameras throughout a parking garage. Each unit **16** is designed to monitor one or more parking spaces **15** through directly detecting occupancy in the specific parking space **15**. In the example of FIG. **1**, each unit **16** monitors two parking spaces **15**. Furthermore, an energy efficient multicolor LED indicator within unit **16** may be used to indicate the occupancy status of that space **15**. For example, a green light may indicate the space **15** is vacant and available for general parking, a blue light may indicate that space **15** is vacant and available for handicapped parking only, and a red light that the space **15** is occupied. In addition to or in place of illumination fixtures **24**, energy efficient LED area illumination can also be incorporated into unit **16**, with the illumination via units **16** and/or via fixtures **24** controlled by system controller **44** on the basis of local occupancy levels, conserving energy when occupancy levels are low.

Digital scoreboard signs, such as row displays **18**, showing the number of vacant spaces **15** in a particular physical area of the parking lot such as the rows of aisles **11**, **12** and **14**, can be updated by system controller **44** directly, or via row controllers **42**.

In one specific embodiment, the system configuration provides centralized access and control down to the individual space **15** level. System controller **44** connects to up to 512 individual row controllers **42** over an extended range Ethernet CAT5e network. Each row controller **42** can be attached to up to 4 rows of 128 individual camera units **16** per row, for a total of 512 cameras per row controller **42**. Each camera unit **16** can monitor one or more parking spaces **15**, either on opposing sides of the camera unit **16** or in side by side parking bays **15**. Thus a single system of the present invention can monitor and control up to one million individual parking spaces **15**.

FIG. **3** is a high level block diagram of a camera unit **16**. Camera unit **16** is used to detect, identify and indicate the occupancy of a garage parking space **15**.

Each camera unit **16** includes:

- high intensity red, green, and blue LED indicators **48** with diffuser
- two high resolution, high sensitivity CMOS multi-megapixel digital cameras **50**
- one or more 400 MHz ARM9 processor **52**, available from ARM Ltd. of Cambridge GB, with SDRAM **54** and flash memory **56**
- two 10 Mbyte/second RS-422 serial ports **58** for daisy chain installation (or 3-port Ethernet switch)
- optional LPR (License Plate Recognition) software in flash memory **56**

Row controller **42** attaches to system controller **44** through extended range CAT5e Ethernet. Each row controller can control up to 4 rows of 128 dual camera modules **16** per row. Because each camera module **16** can monitor multiple spaces, a row controller **42** can monitor more than 1024 parking spaces (in two opposing rows).

Each row controller **42** can be used to control multiple independent signs **18** through two independent RS-422 interfaces.

FIG. **4** is a high-level block diagram of a row controller **42**. Each row controller **42** includes:

- embedded computer module **86** with ARM processor **88**, SDRAM **90** and flash memory **92**
- ethernet switch interface **94**
- up to 4 RS-422 camera module interfaces **96**
- up to 2 sign control interfaces **98**

These components communicate with each other via a bus **100**.

System controller **44** is a desktop or server grade computer that monitors the entire system and provides a user interface **46** to other external systems that can connect to the parking system. The system is designed in a way that the parking lot signs **18**, row controllers **42**, and camera units **16** can run even if the system controller **46** is unavailable.

In another exemplary embodiment, camera modules **16** communicate via Ethernet through an on-board three-port

Ethernet switch such as the Micrel KSZ8873MLL available from Micrel, San Jose Calif., USA. System controller **44** can then be connected directly to camera units **16**, without the intervening row controllers **42**. Standard network components such as routers and switches can be used to extend the network in a star topology across any physical layout. In that case, the number of camera units **16** per row is effectively unlimited.

In another exemplary embodiment, peripherals such as digital scoreboard signs **18** are connected to the same Ethernet network, either directly or via Serial-to-Ethernet conversion, and are updated through the network by system controller **44** or by row controllers **42**.

In another exemplary embodiment, camera units **16**, which may be serial or Ethernet based, are mounted in the center of the driving lane and have two cameras **50**, one per side, to monitor bays on opposite sides of the lane. If either of the two spaces **15** is vacant, then LED indicator **48** is turned green to show a vacant regular space and blue to show a vacant handicapped space. If both spaces **15** are occupied, LED indicator **48** is turned red.

In another exemplary embodiment, each camera **50** is aimed such that two adjacent parking spaces **15** are visible in its field of view, so that the camera unit **16** captures information about up to four spaces **15**. In that case, if at least one of four (or one of three, or one of two) spaces **15** is vacant, LED indicator **48** is turned green to show a vacant regular space and blue to show a vacant handicapped space. If all spaces **15** are occupied, LED indicator **48** is turned red. This architecture can be further embellished to include N spaces per camera **48** (and thus 2*N spaces per unit **16**), provided all N spaces are visible in the field of view of camera **48**. Wide-angle lenses can be used to increase the field of view of camera **48**.

One preferred aspect of the system is the ability to automatically determine the network topology and map camera units **16** physically onto a map of the parking structure. This can be achieved in a variety of ways, depending on the specific embodiment of the invention:

1. Serial Communication

Packet Decoding Method

For serial communicating camera units **16**, each packet gets retransmitted by a camera unit **16** if destination address is somewhere down the row. Each packet includes a header with several fields necessary for discovery of the location of a camera unit **16**:

"original address"
"source address"
"destination address"

When packet is received, camera unit **16** checks if a location was assigned. If not, the following applies:

- Camera unit **16** checks for a source address. The source address is the address of row controller **42** or the first neighbor on the way to the row controller **42**. IF ID is 0, then camera unit **16** is the first on the row.
- Camera unit **16** increments the source address of the packet and assigns its own ID.
- Camera unit **16** also marks the port where packet was received as HOME port and the other as AWAY port. HOME port is the port towards the row controller **42**.
- After location is assigned, camera unit **16** uses this ID to mark all outgoing packets in the "source address" field.

2. Ethernet Sorting Version 1

Server Initiated Topology Discovery and Sorting Algorithm

This method assumes that the network of camera units **16** is organized into several IP subnets, each with one or more daisy-chain strings of nodes (star topology).

1. System controller **44** sends "Get Version" request to each IP in the IP network group to find out number of camera units **16** and their IP/MAC addresses.
2. System controller **44** assembles a list of all active camera units **16** in the network group.
3. System controller **44** issues request to each camera unit **16** to ping the assembled list of camera units **16** in order to populate MAC table of its Ethernet switch.
4. System controller **44** requests MAC tables from all camera units **16**.
5. System controller **44** performs topology discovery and sorting algorithm as follows:

Topology Discovery Algorithm:

System controller **44** finds end camera units **16**. End camera units **16** do not have any other camera unit **16** MAC addresses on one of the ports of their Ethernet switch.

System controller **44** chooses randomly a single end camera unit **16**.

System controller **44** builds a route by selecting another end camera unit **16** and checking all camera units' **16** MAC tables. A camera unit **16** belongs to this route if both end camera unit **16** MACs are located on separate ports of the camera unit's **16** MAC table. Each camera unit **16** is checked and route is built as a list.

System controller **44** finds the first end camera unit **16** by checking the table for either the System controller's **44** MAC or the router's MAC. The First System controller's **44** MAC should be located on the same port with the System controller's **44** MAC.

Sorting Algorithm

System controller **44** picks a random camera unit **16** in a middle of the discovered route.

System controller **44** moves all camera unit **16** of the route on either side of the selected camera unit **16** based on a MAC location in the selected camera unit **16** MAC table. For example: camera unit **16** that appeared on port 0 are moved to the left of the selected camera unit **16**, and the rest are moved to the right. The selected camera unit **16** becomes "top" of the two branch tree.

System controller **44** chooses right branch first and walks through the camera unit **16** applying a sliding window of three camera unit **16** including the top camera unit **16**. System Controller **44** arranges the three camera unit **16** between each other.

System controller **44** slides the window down by one camera unit **16** and performs arrangement again until the bottom is reached.

System controller **44** slides the window again from the top until no camera unit **16** are shifted in this branch.

The left branch is sorted the same way. This can be done in parallel with the right branch in two separate threads. Sorting of the branches is an independent task.

System controller **44** builds routes for remaining end camera units **16** and repeats sorting for each branch.

Every time routes cross on a camera unit **16**, system controller **44** marks camera unit **16** as joint camera unit **16**.

At the end we've got a sorted tree which can have any number of branches and cross-branches.

3. Ethernet Sorting V2

Camera Unit **16** Initiated Topology Discovery

This sorting method includes a requirement that the network avoid branching, and that each string of camera units **16** exists on a single router entry. This method invokes two components: TDD: Topology Discovery Daemon—a program running constantly in the background on the ARM processor of each camera unit **16**, and a SensorIdentity library which is called on demand by the main application running on the camera unit **16** to find out its location at any time. The TDD daemon's main responsibility is to refresh all MAC tables in the string.

- TDD is called by a watchdog agent on the TDD's camera unit **16** every 30 seconds.
- TDD checks if its camera unit **16** is the last camera unit **16** in the string. TDD gets MAC table from the camera unit **16** Ethernet Switch and checks if there are no camera unit **16** MAC entries on one of the ports.
- If the TDD's camera unit **16** determines that it is the last camera unit **16** in the string:
  - TDD gets broadcast address from socket control functions.
  - TDD sends ping for a single packet on the broadcast address. This ensures that each camera unit **16** in the string receives the ping packet and that the MAC table of the Ethernet switch of each camera unit **16** in the string gets populated.
  - TDD exits.

SensorIdentity library is called by the main application running on the camera unit **16** to get its location ID in real-time. SensorIdentity library performs the following actions:

- Gets gateway address from network tools (socket control functions)
- Finds MAC address of a gateway by ARPing the address.
- Finds which port of the MAC table includes the gateway MAC.
- Calculates the number of camera unit **16** on the same port.
- The camera unit **16** location ID is the calculated number+1.

Vehicle and Event Detection Algorithms

In one embodiment, the car detection algorithms run inside each camera unit **16**, and work even if the connection to the row controller **42** is missing. Periodically, for example several times a second, an image is captured by the internal CMOS sensor of the camera unit **16** and is transmitted to the SDRAM **54** of the unit **16**. ARM processor **52** in unit **16** then examines the image, calculating several metrics based on the content of the current image. These metrics are fed into a classification routine which has been previously trained on several thousand car and empty space images. The output of this classifier determines if a car is in the space **15** or not. Based on the values of the metrics, different types of vehicles and objects can be determined. Any classification routine or machine learning algorithm can be used; some common algorithms in the literature include Classification and Regression Trees, Support Vector Machines, and Artificial Neural Networks.

In one extension to the method described above, the metrics that are computed can themselves be learned from training data, using a variety of methods known in the art such as Kernel Methods, Principal Components Analysis, Independent Component Analysis, Feature Detection Methods, etc.

In a second extension, the determination of parking space occupancy can take into account time and historical activity. For example, using methods of background modeling, the detection routine can learn a model of the empty space over time and compare new images to the learned model to determine if a vehicle has entered or exited. Another implementation could use a change detection algorithm to determine when an event has occurred in the parking space (i.e. a car has entered or departed), by computing a running average or variance of the image or some other aspect or aspects of the image, and comparing the aspect of the image to the same aspect of each other image frame.

In a third extension, both of the above methods could be combined to provide a more accurate and robust method to detect vehicles in the parking space. For example, the output of the classifier could be used as feedback for the modeling routine to refine or prune its model. This could be further refined by using the "confidence" value of the classification output. In addition, the change detector could be used to bias the decision, depending on the current state. Moreover, the combination of methods can be tuned to trade off between false alarms (saying the space is occupied when it is really empty) and misses (saying the space is empty when it is really occupied), depending on the operator's preference.

In a fourth extension, a complete time- and history-dependent Markov model of the parking space can be constructed and updated in real-time. For example, at each time step (usually the acquisition time of a single image), the likelihood of the space being occupied is a function of the previous state, the current image metrics, the previous n image metrics, and the current time. This function can be optimized offline from training images, or can be learned and updated in real time.

The decision space of any or all of these algorithms can be expanded to include other events or characteristics to be detected, such as vehicle make, model, class, and color, as well as security events such as suspicious activity and physical violence.

License Plate Detection Algorithm

License plate detection by a camera unit **16** occurs in two stages. First, the image patch containing the license plate can be found using a variety of methods, such as template matching, or edge detection, looking for rectangular edges in the image and finding the most likely candidates for a license plate, based on the relative location and aspect ratio of the license plate. The license plate image is then processed by an Optical Character Recognition (OCR) routine that determines the values of the text and symbols contained in the license plate. This information is then transferred to system controller **44** (directly, or via the row controller **42**) for storage and use.

In alternative embodiments, any or all of these algorithms run in the row controllers **42**, in the system controller **44**, or in the Ethernet level, or in a combination thereof. For example, in one such embodiment a camera unit **16** detects a vehicle entering a parking space and notifies system controller **44**. System Controller **44** then requests a high resolution image from that camera unit **16**. When system controller **44** receives the image from the camera unit **16**, system controller **44** processes the image to extract the

license plate image and presents the extracted license plate image to an OCR module for text extraction.

Additional Features

Find Your Car Feature

The system captures and analyses license plates and their location to the individual spaces **15** in parking lot **10**. A customers enters his/her license plate number at the one of the entry kiosks **20** or **21**, to locate the exact space at which the vehicle is parked. FIG. **5** shows exemplary screen captures, from the display screen of an entry kiosk such as entry kiosks **20** and **21**, of the process. The customer may either key in the license plate number, make or color of car. Alternately, in an embodiment in which a camera similar to camera **50** in the relevant entry kiosk **20** or **21** captured the customer's license plate number when the customer's vehicle entered parking lot **10** and encoded the license plate number in the access ticket issued by the entry kiosk, the customer inserts the access ticket into the entry kiosk, which reads the encoded license plate number. System controller **44** then compares the information entered or encoded on the access ticket to its database of vehicles currently parked in the lot, and returns a picture of the most likely match, along with any other partial matches, as shown in the left screen capture of FIG. **5**. The customer can then visually inspect and confirm the image. The kiosk then displays and/or prints a map with the route to the corresponding parking space, as shown in the right screen capture of FIG. **5**. FIG. **11** shows a flowchart of this embodiment of the "find your car" feature.

In an alternative embodiment, the customer may use his/her smart phone or similar mobile device instead of a kiosk. For example, the customer could take a picture of a "QR code" printed on a sign near the parking lot, which will direct the phone's web browser to a website where the customer can enter the vehicle information as in the kiosk method. Each QR code can be associated with a specific spatial location, allowing the system to compute a route from the customer's specific location. FIG. **12** shows a flowchart of the alternative embodiment of the "find your car" feature.

FIG. **6** is a partial high-level functional diagram of entry kiosk **20** or **21**, showing the functional elements of entry kiosk **20** and **21** that may be needed for the "find your car" feature. Kiosk **20** or **21** includes a camera **62**, similar to camera **50**, for capturing identification images of vehicles entering parking lot **10**, a keyboard **64** at which a customer types the license plate number of his/her vehicle, a display screen **66** for displaying responses such as shown in FIG. **5** in response to the customer's inquiry, a printer **68** for printing access tickets, a reader **70** for reading access tickets and a transceiver **72** for communicating with customers' mobile devices. Components **62**, **64**, **66**, **68**, **70** and **72** are under the control of an entry kiosk controller **60** via a bus **74**.

In another embodiment, the customer's smart phone location-awareness can be used to compute a route to the parking space from the customer's current location. With a precise location-aware system, such as a location-aware system based on WiFi time-difference-of-arrival, the customer can be directed with turn-by-turn directions, or through an updating, homing-beacon process.

Tiered Parking Control

Under the tired parking control scheme, the cost of parking varies depending on the location of each individual parking space **15**. The present invention records the license plate of a vehicle on entrance to the car park, using a camera in the relevant entry kiosk **20** or **21**, and reconciles the ticket with the license plate number captured at the individual parking space **15** by camera unit **16**. Alternatively, the individual space number is reconciled with the license plate under a pay by space format. Finally, the customer may attach a prepayment to the customer's license plate number, and the system can automatically bill the customer for the exact space the customer parks in. This method allows billing of customers for use of a specific parking space at a specific time without requiring any form of physical access control such as barrier gates, ticket or credit card payment terminals. Following reconciliation on system back-end software, a tariff is charged based on the location of the parking space at the automated pay station of the garage. This enables differential pricing to be efficiently varied based on the location, type or demand down to the individual space of the car park. Alternately, this could be varied by amount of time spent in car park, number of previous times a vehicle has been parked, etc

Permit Parking Control

Detection algorithms in the system software are capable of identifying permit badges to ensure that parking spaces that are allocated for permit use are occupied by authorised permit holder only. If a permit is not displayed, the system takes a picture of the vehicle for infringement processing. Parking garage management need no longer allocate a nested staff area; simply create a designated area and staff will be notified if they park outside this area. In an alternative embodiment, permit parking can be allocated by license plate, or unique combination of vehicle make, model, color, and other identifying marks.

Parking Lot Lighting and Ventilation System Efficiency Enhancement

Since the system of the present invention enables all parking slots **15** to be surveyed in real time, illumination of slots and driveways can be controlled according to real time usage of each parking space **15**. As a result, lighting levels can be changed for individual spaces, zones or floors, e.g. via differential control of lighting fixtures **24**, leading to energy power savings. Furthermore, the same is true for ventilation systems whose power output and usage levels can automatically be adjusted based on individual parking space **15** utilization e.g. via differential control of ventilation vents **23**.

Customer "Profiling"

Different types of cars may correlate to different types of fee structures. Furthermore, different types of vehicles, such as hybrids, vehicles with permits, or vehicles subject to manufacture promotions, may be allowed to park in individual spaces **15** at a discount or premium. The detection algorithms are able to correlate the type of car to the promotion, discount or incentive. Furthermore, vehicle identification can be linked to customer loyalty rewards programs, allowing operators to provide shopping incentives at the point of parking. More details of such loyalty programs are provided below.

Enforcement

The system can track in real time whether a particular parking space **15** is correctly occupied, for every parking space **15**, 24 hours a day. If a vehicle stays longer than the proscribed length of time, enforcement action can be taken automatically using vehicle identification information (e.g. license plate) or manually by alerting enforcement personnel. Other infractions to parking rules and regulations, such as a single vehicle occupying more than one space **15**, can also be detected and acted upon.

Object Type Detection

Via image processing algorithms run either in camera units **16** or in row controllers **42** or in system controller **44**, the system can monitor the type of object that is parked in a space **15**. This can identify the make and model of a vehicle, and also tell if the item parked in the space **15** is a motorcycle, parking cart or a person. This can be used to notify the parking lot manager that the parking cart needs to be removed, that someone is loitering in the parking lot, or other such uses.

Security

The image processing algorithms are capable of detecting other types of events, including suspicious activity that might indicate a theft in progress or a physical attack on a customer. This information can be sent to security personnel for immediate action, thereby improving the accuracy and coverage of existing closed circuit camera systems and other security measures already in place.

Remote Monitoring and Control

System controller **44** can be connected to the Internet, as shown in FIG. **2**, enabling a large-scale system for real-time monitoring and control of any parking lot **10** from anywhere in the world. This can be achieved through a client-server architecture that combines software running on a remote computer, Internet-based communications, and server software running on system controller **44**. In the following discussion, the term "server" refers to server software running on system controller **44**. This remote monitoring system can be used for the following purposes:

- Remote monitoring of parking spaces **15** for security and enforcement
- To improve the accuracy of the automatic detection through human intervention
- As an input to the automatic detection algorithm, to refine the computer vision models by correcting errors and providing new labeled data
- To identify system faults such as broken cameras **50**, **62** and take corrective action.

In one embodiment of this system, system controller **44** keeps a copy of a thumbnail image from each camera **50** on the site. When any of the following three actions are triggered, system controller **44** requests an image from the associated camera unit **16** and places it into a server-side cache located on the system controller **44**:

a) The camera module **16** notifies the system controller **44** that an entry/exit was detected by sending a Visit Event

b) The camera module **16** notifies the server that camera module **16** image has changed by sending a Change Detected Event

c) The system controller **44** cached copy of the thumbnail is greater than 10 minutes old

The parking lot manager interfaces with the system through a web browser, opened to a web page that is served up by system controller **44** using a combination of HTML and JavaScript. An example of the web page user interface is shown in FIG. **7**. In this overview monitoring system, the parking lot manager selects one or more zones that s/he wishes to monitor. A zone is a group of bays **15**, usually an entire level of parking spaces.

Every 10 seconds, a periodic task running in the web browser client queries a JSON webservice on the system controller **44** that returns the list of all bays **15** in the selected zones. The response includes a timestamp of each of the server's thumbnails. If the client's copy of the thumbnail is out of date (or it has never been downloaded) the client downloads the thumbnail from the server and inserts the thumbnail onto the page.

The page is split into 4 buckets. In each bucket, there is a grid of the thumbnails belonging to that category. The manager can click on any images associated with incorrect detection decisions to toggle the override mode of a camera unit **16**. If the camera unit **16** is in automatic mode, a mouse click forces it to the opposite detection decision. If the camera unit **16** has been forced into an overridden state, a mouse click puts the camera unit **16** back into automatic mode. Based on its next detection decision, the camera unit **16** will go to the VACANT or OCCUPIED state in automatic mode.

The following table shows how the manager corrects erroneous detection decisions.

State	New State	Why the user should click
VACANT in automatic detection mode	FORCE_OCCUPIED	There is a vehicle visible in the image that was not being detected by the algorithm
FORCE_VACANT (override active)	Automatic mode	There is a vehicle visible and the camera module 16 had been forced into a vacant mode. The click puts the camera module 16 into automatic mode and it goes into VACANT or OCCUPIED in automatic mode based on the outcome of the detection algorithm's decision
OCCUPIED in automatic detection mode	FORCE_VACANT	There is no vehicle in the image, and it is being detected as occupied by the algorithm
FORCE_OCCUPIED	Automatic mode	There is no vehicle in the image but the camera module 16 had been forced into a OCCUPIED mode. The click puts the camera module 16 into automatic mode and it goes into VACANT or OCCUPIED in automatic mode based on the outcome of the detection algorithm's decision

Of course, such correction of erroneous detection decisions also can be done locally, directly at system controller **44**.

The decision space of the grid can be expanded to allow error correction and model update for other types of decisions, such as vehicle make, color, vandalism, etc.

In an alternate embodiment, the system is further optimized for allowing human intervention for correcting errors

and updating models, either off-line or in real-time. In this case, human intervention to correct detection mistakes and label data takes the form of a simple web-based game, as depicted in FIG. **8**. The human operator is presented with two grids of up to 9 images each. In the grid on the left, thumbnails are displayed of bays **15** that the vision algorithms have labelled as being occupied. Similarly, on the right are thumbnails of bays **15** that the algorithm has labelled as vacant. The human operator must click on any mislabeled data on the screen before submitting the changes to the server. A 30 second timer and the tracking of how many corrections have been made can be used to incentivize the operator to make many corrections as fast as s/he can.

As this preferably is a distributed system allowing many simultaneous operators to label the data, the server must decide which images are being allocated to users. The server maintains a priority queue, and a client request for images returns a block of images with the highest priority. These images are immediately removed from the priority queue to ensure that each user is getting a unique set of images. Each of the following criteria adds to the image's priority score, with the highest scores denoting the images with the highest priority:

1. The camera module **16** detected a significant change in its image
2. The camera module **16** is currently overidden
3. This parking space has previously been marked as incorrect (for spaces with recurring errors)
4. The algorithm's detection confidence is low
5. This space has not been "watched" for more than 20 minutes

FIG. **9** is a high-level partial block diagram of an embodiment of a system controller **44** that is configured to support such interactive correction of the parking space occupancy detection algorithm. This system controller **44** includes a non-volatile memory **76** such as a hard disk or a flash disk, a processor **78**, a display device **80** such as a display screen, and a manual input device **82** such as a keyboard or a mouse, all communicating with each other via a bus **84**. This system controller **44** also is coupled, usually indirectly (as indicated by the dashed arrows), to camera units **16** to receive occupancy images of parking spaces **15**. Non-volatile memory **76** is used to store executable code **77** for classifying the occupancy images as occupied or vacant, for displaying these classifications on display device **80**, for receiving corrections of these classifications via manual input device **82**, and for modifying the classification algorithm in response to the corrections to make the classification algorithm more accurate, as described above.

Non-volatile memory **76** is an example of a computer-readable storage medium bearing code for classifying occupancy images, for interactively correcting these classifications and for modifying the classification algorithm.

Efficient Mapping of Sensor Locations

To enable any method that requires knowledge of the location in a parking lot **10** of a specific parking space **15**, we need a method for mapping each camera unit **16** to the specific parking bay or bays **15** that the camera unit **16** monitors. The naïve approach is to manually record the unique address (MAC, IP, etc) of the corresponding camera unit **16** for each bay **15**, along with the bay's unique number. These numbers can be linked and cross-referenced in a table or a database. In addition, the bay locations can be manually marked on a map image of parking lot **10**, for use in helping customers find their cars, or for providing a pictorial view of the parking lot occupancy status to the parking lot manager.

Unfortunately, the process of manually recording and associating parking bays **15** with camera units **16** is extremely time consuming, costly, and error prone. Moreover, if the physical layout changes at any time during the life of the system—for example, if a camera unit **16** is replaced, or if the bay locations are changed—the associations must be manually updated to ensure the mappings remain accurate.

A better method is to use automatic discovery of the network topology to simplify the process of mapping bays **15** to camera units **16** in software. The system of the present invention can use any of a number of automatic topology discovery algorithms to identify and map the topology of the network of camera units **16**, including the Packet Decoding Method described above for serial communications, the Server Initiated Topology Discovery and Sorting Algorithm described above for Ethernet communications, the Sensor Initiated Topology Discovery Algorithm described above for Ethernet communications, or any of a number of protocols known in the art, such as the Spanning Tree algorithm used by the Simple Network Management Protocol (Internet Engineering Task Force RFC 3411—An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks).

Once the network topology is known, mapping bays **15** in a map image and associating them with camera units **16** is simply a matter of associating just one camera unit **16** of each string of camera units, as recorded in the network topology, with the intended map coordinates of that camera unit **16** and of the bay(s) **15** that that camera unit **16** monitors. Because system controller **44** knows the network topology and also knows the map coordinates of all camera units **16** and of all the other bays **15**, system controller **44** can associate all the remaining camera units **16** with their respective map coordinates and with the map coordinates of the bays that those camera units monitor. FIGS. **10**A-**10**D are screen captures of a graphical user interface (GUI) that illustrate how this can be done simply in a single step, as follows:

1. User loads a map image of the parking lot, such as an engineering plan or other pictorial of the parking lot layout, into the GUI.
2. User marks the locations of the parking bays **15** by placing "bay pushpins" at the appropriate places in the image, as illustrated in FIG. **10**A. The software automatically saves the relative x- and y-coordinates in the image for each bay pushpin.
3. User marks the locations of camera units **16** by placing "camera pushpins" at the appropriate places in the image, as illustrated in FIG. **10**B. The software automatically saves the relative x- and y-coordinates in the image for each camera pushpin. Note that at this point the system knows the map coordinates of camera units **16** but does not yet know which camera unit **16** goes with which map coordinates.
4. User associates each bay pushpin with a camera pushpin by drawing a line from the bay pushpin to the camera pushpin, as illustrated in FIG. **10**C. A camera pushpin can be linked to multiple bay pushpins, but each bay pushpin can only be linked to a single camera pushpin.
5. User links the camera pushpins in a string by drawing a line to connect them, as illustrated in FIG. **10**C. A camera string corresponds to a physical string of camera units **16** daisy-chained together. A camera string begins at a "root node" attached directly to a row controller or an IP

network switch, and terminates at an "end node" which is a camera unit **16** that has one empty communications port (either Serial or Ethernet switch).

6. User opens the Topology Discovery Tool window and finds the appropriate camera string, identified by the IP address of the row controller or Ethernet switch attached to its root node, as illustrated in FIG. **10**D.
7. User selects the camera pushpin corresponding to the camera string's root node (this pushpin is shaded in FIG. **10**D), and presses Apply in the Topology Discovery Tool window. The software automatically links and cross-references the camera pushpins along the camera string with the physical MAC addresses of the camera units **16**, in order, according to the discovered network topology.
8. The user repeats this process for every physical string of camera units **16** in the parking lot.
9. If a camera unit **16** is ever replaced, the system can detect a change in the topology and automatically update the mapping to reflect the new change without requiring user intervention.
10. If bays **15** are ever moved or reconfigured or added or removed, or if camera units **16** are added or removed, the user can easily detect and correct the change using the GUI.

FIG. **9** serves to illustrate a system controller **44** configured to map the locations of camera units **16** as described above, provided that executable code **77** is understood as executable code for implementing the mapping of the locations of camera units **16** as described above. Non-volatile memory **76** then is an example of a computer-readable storage medium bearing code for mapping the locations of camera units **16** as described above.

Loyalty Programs

The information collected by the system can be used to enhance customer loyalty and shopping incentive programs by identifying customers automatically as soon as they park their car and notifying the customers and/or the merchants and/or the parking lot manager of qualifying loyalty rewards, shopping incentives, discounts, and other targeted programs Customers can be notified directly in the parking space **15**, or at any point between the garage entrance **30**, **31** and the parking space **15**, or at any point between the parking space **15** and the customer's ultimate destination such as a store, restaurant, or shopping area. Advertising can be in the form of audio and or visual signals, presented through one or more audio speakers and/or one or more video displays that are integrated with the system or that can communicate with system controller **44**, and/or with row controllers **42**, and/or with camera units **16**. This can be achieved as follows:

1. Customer parks car in a parking space **15**.
2. A camera unit **16** detects a car and sends an image of the car to system controller **44**.
3. System controller **44** extracts the license plate number from image acquired by camera unit **16** and compares the extracted license plate number to a database maintained either on system controller **44** or on a server co-located on a network such as the Internet. Alternatively, the license plate could be extracted directly on the camera unit **16** and sent to system controller **44**.
4. If a user record is found matching the recorded license plate, system controller **44** triggers a loyalty program event, which can include any or all of the following:
   a. Offer audio and/or visual advertisements and/or shopping incentives and/or other loyalty rewards directly to the customer in the parking space **15**, through a speaker and/or video panel integrated into the camera unit **16** or external to it.
   b. Send advertisements and/or shopping incentives and/or notification of other loyalty rewards directly to the customer via mobile phone.
   c. Link discounts and other point-of-sale offers directly to the customer's loyalty account, which will be applied at point-of-sale when the customer uses his/her loyalty program card or a credit card associated with the account.
   d. Notify stores in the shopping area that the customer is on-site, allowing the stores to offer qualified incentives, advertisements, and discounts directly to the customer.

Advertising

The information collected by the system can be used to target advertising to specific demographics as soon as a customer parks his/her car. This can be done even without the use of license plate recognition and/or without consulting a user database, by examining demographic information such as make and model and color of the vehicle, license plate design, and other identifying marks such as bumper stickers and sports team insignias. Advertising can be presented to the customer directly in the parking space **15**, or at any point between the garage entrance **30**, **31** and the parking space **15**, or at any point between the parking space **15** and the customer's ultimate destination such as a store, restaurant, or shopping area. Advertising can be in the form of audio and or visual signals, presented through one or more audio speakers and/or one or more video displays that are integrated with the system or that can communicate with system controller **44**, and/or with row controllers **42**, and/or with camera units **16**. This can be achieved as follows:

1. Customer parks car in a parking space **15**.
2. A camera unit **16** detects a car and sends an image of the car to system controller **44**.
3. System controller **44** extracts from the image anonymous demographic information such as: make/model/color of vehicle, license plate information, symbols and bumper stickers (such as sports teams, university, political affiliation, etc). Alternatively, this information could be extracted directly in the camera unit **16** and sent to system controller **44**.
4. if demographic information is found, system controller **44** can offer audio and/or visual targeted advertisements directly to the customer in the parking space **15**, through a speaker and/or video panel integrated into the camera unit **16** or external to it.

Valet Parking

The system can be used to simplify the process of valet parking for the valet operator, and enhance the valet parking experience for the customer. This can be achieved as follows:

1. Customer arrives at valet stand, receives a ticket with a unique i.d. number on it. Number can also be encoded in a bar code or QR code.
2. Valet parks car in a parking space **15**.
3. A camera unit **16** detects the car and sends an image of the car to system controller **44**.
4. System controller **44** extracts the license plate number from the image and automatically associates the license plate number with the ticket i.d. number. Valet can also manually associate the license plate number with the

ticket i.d. number using a terminal or handheld portable device, or using a bar code reader. The license plate number could also be extracted directly by the camera unit **16**.

5. Customer can surf to a website at any time to see a live image of his/her car to ensure that the car is safe. The website can be accessed from any web browser or through a smart phone application, or the URL of the website can be encoded into the QR code so that the customer can simply scan the QR code with his/her smart phone to open up the website to the appropriate page. The customer can manually enter his/her license plate number to locate and view the live image of his/her car.
6. The customer can enter his/her phone number or email address through the website or through a phone application to be automatically notified if the car moves.
7. The customer can use the website or the phone application to alert Valet that s/he is returning, so the valet has the car ready when s/he returns.
8. The valet simply enters the ticket i.d. number into the terminal or into a handheld device, or scans the bar code, or enters the license plate number, and the system tells the valet which parking space number is associated with that record, and may even display a map so that the valet can easily locate the vehicle.

Renting Out Private Spaces

In a mixed-use (commercial+residential) facility, the system enables residents to rent out their spaces if/when they aren't using them. This can both increase the effective capacity of a commercial parking garage, and provide a monetary incentive or subsidy to residents. This can be achieved as follows:

1. When a resident signs a lease or purchases a parking space or purchases a residential or commercial unit, s/he get an online account associated with his/her parking space(s) **15**.
2. A resident can log on to an online system to access and manage his/her account.
3. A resident can configure his/her account with his/her license plate number, phone number, email address, and any other identifying information.
4. A resident can configure the system to automatically notify him/her if a car with an unknown license plate parks in his/her space **15**.
5. A resident can opt-in to a system that allows his/her space **15** to be used by visitors to the commercial entities that share the parking lot **10**. This can be 24 hours/day, or for fixed time periods and/or specified days of the week/month/year. This can also be configured in the online system, or by phone or at a kiosk or in person with the parking manager.
6. If a visitor parks in the resident's space **15** during the designated times, the resident either receives a percentage of the parking revenue, or a share of the facility's revenue calculated as a percentage of the revenue collected from the entire pool of shared private spaces. Money can be disbursed as a credit against rent, or directly as a deposit into the resident's bank account, check, money order, cash, PayPal™, etc.

Individual Security Monitoring

When parking a car, particularly in a public parking lot, safety and security of the vehicle is a major concern for many people. The system can be used to provide an extra measure of security by allowing customers to monitor their vehicles directly, as follows:

1. Customer loads a smart phone application, or navigates a web browser to a particular web site, or sends a text message to a particular phone number, and enters the unique identification number printed on the access ticket received upon entry to the parking lot **10**.
2. System controller **44** receives request, queries its database for the vehicle record, and responds with a live or recent (e.g. within the past 5 minutes) image of the vehicle in the parking space **15**.
3. Customer can configure the system, through the web site or phone application or via text message commands, to automatically alert the customer via text message and/or email if any of the following occurs:
   a. The image captured by camera unit **16** of parking space **15** has changed compared to a previously captured image; this could indicate an attempt to vandalize or break into the vehicle.
   b. The parking space **15** has become vacant; this could indicate a possible theft of the vehicle.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made. Therefore, the claimed invention as recited in the claims that follow is not limited to the embodiments described herein.

What is claimed is:

1. A method of managing a plurality of parking spaces, comprising:

(a) monitoring a parking space with an imaging device of an imaging unit;

(b) detecting, by said imaging unit, occupancy of said parking space;

(c) assigning said parking space, in which said occupancy was detected, an occupied status, wherein said occupied status is indicated by illuminating a first color of a multicolor indicator collocated with said imaging device, said first color predefined to determine said occupied status;

(d) obtaining, as a result of said parking space having said occupied status, a single high resolution image of a vehicle occupying said parking space, said high resolution image obtained by said imaging device;

(e) storing at least part of said high resolution image on a storage device;

(f) displaying a thumbnail image of said parking space on a graphic user interface (GUI), said thumbnail image digitally processed from an image electronically communicated to said GUI from said imaging unit;

(g) deciding whether said occupied status is incorrect, based on a visual review of said thumbnail image on said GUI;

(h) correcting said occupied status, by inputting computer-readable instructions to a computer terminal of said GUI, if said parking space shown in said thumbnail image is vacant and said computer terminal electronically communicating a command to toggle said multicolor indicator to illuminate a second color, said second color predefined to indicate a vacant status;

(i) extracting from said high resolution image, by digital image processing, a permit identifier for said vehicle and comparing said permit identifier with at least one parking permit identification stored on said storage to determine a permit status of said parked vehicle; and

(j) initiating an infringement process for said vehicle having said permit identifier that fails to coincide with at least one of said at least one parking permit identification.

2. The method of claim **1**, wherein said detecting includes providing machine-readable code of a self-modifying classification algorithm for assigning said respective statuses, the method further comprising:

(e) said system executing said machine-readable code to modify said classification algorithm in response to said correcting.

* * * * *

San Diego airport adds more parking spaces with three-level, high-tech garage

The airport's new parking garage incorporates public art that also helps guide people to where they parked. (Pablo Mason / San Diego Regional Airport Authority)

By **Lori Weisberg**

MAY 17, 2018, 6:00 AM

Starting Friday, travelers and visitors heading to the airport will be able to park in a new three-level garage just steps from Terminal 2.

The culmination of a nearly two-year construction period, the 2,900-space, $127.8 million parking plaza replaces a previous surface lot located closest to the San Diego International Airport's Terminal 2.

Besides offering covered parking at rates identical to the hourly and daily fees of the former lot, the garage is outfitted with a guidance system employing LED signs and colored lights to alert motorists to vacant spaces.

While the garage will initially represent a net gain of 1,715 spaces, that gain will turn to a loss later this year when the airport undertakes yet another project — a combination cargo, airline and airport maintenance facility that will occupy a portion of the long term lot where employees now park. Those workers, in turn, will have to start parking in the economy lot on Pacific Highway, which will be closed to the public.

The result will be a net loss of 230 spaces available to the public, said Jonathan Heller, spokesman for the San Diego Regional Airport Authority.

Even with the rise of ride-hailing apps like Uber and Lyft that offer relatively affordable transportation to and from the airport, the demand for on-site parking remains high, says April Boling, who chairs the Airport Authority board. As an example, she pointed to the 450 valet spaces that mid-week are nearly always full.

"When we had assessed our customer satisfaction several years ago, the area where the flying public had the least satisfaction was with parking and particularly close-up parking," Boling said. "So we understood the need for a parking plaza immediately adjacent to the terminal and that's what we've built.

"And the people who are parking in that plaza aren't necessarily staying for an entire day, some might be picking up their relatives from Wisconsin and they want to park close up — we call them the meeters and greeters — and that's way more than half of who is parking there. They're not as price sensitive because they're not paying the $32 a day."

Another big chunk of those parking close to the terminal are business travelers, many of whom are flying to and from their destination in one or two days, Boling added.

Rates start at $2.50 for the first 30 minutes, rising to $6 for a full hour and increasing by $2 increments after that.

A key parking plaza feature that airport officials believe will resonate with the public is the system for guiding people to available spaces. As motorists enter the garage, there will be signage quantifying the number of unoccupied spaces on each floor, and each level will also have signs with the same information.

The guidance system, similar to what is in place at the UTC Westfield mall garage, also employs colored lights — green and red — directing motorists to the available spaces. That system will ramp up over the next several weeks, said Marc Nichols, director of ground transportation for the airport.

There also is a smartphone app that allows people to reserve and pay for spaces in advance.

"I don't think the garage will change the mix of travelers who are using it, but it will be much more convenient," Nichols said. "The fact that it has two covered floors will also be very attractive, especially longer term travelers, and the fact that it has that guidance technology will make it much more efficient."

Incorporated into the garage's design are public art pieces, including one that is made up of brightly colored screens fashioned from hundreds of resin airplane models. The garage design is also notable for its glass-front elevators.

The project is being financed largely with parking and concession revenue. The current fiscal year budget estimates parking revenues at $40.6 million, which is expected to grow to $46 million in the coming fiscal year, Heller said.

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At San Diego International Airport we understand the importance of providing great customer service. If you require additional information or have a question about our parking services or facilities, please contact us using the form below. Your message will be sent directly to our Parking Management staff.

Parking management services provided by Ace Parking. For additional questions about Airport parking, please call Ace Parking, 24 hours a day at 619-291-2087.

*** First Name**

*** Last Name**

*** Email**

Phone 1-XXX-XXX-XXXX

*** Subject** Parking Inquiry

*** Message**

CAPTCHA

SUBMIT

DIVISION 11 - EQUIPMENT

SECTION 11 12 01

PARKING GUIDANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Parking guidance equipment, complete, including but not limited to:

1. Vehicle sensors.

2. Signage.

3. Management software and computer hardware.

4. Furnishing and installing all equipment units and control wiring.

5. Training of Owner's designated personnel in the operation and maintenance of equipment.

B. Related Sections:

1. Section 111200 Parking Access and Revenue Control System.

1.2 DESIGN REQUIREMENTS

A. Concept: Parking guidance equipment requirements shown on the Drawings are intended to establish basic dimensions, location of equipment and relationship of the system to other building components.

B. Requirements: Parking guidance equipment manufacturer to design and engineer the entire system, including controls, connections and anchorage to building structure, making necessary additions and modifications to system manufacturer's standard details as may be required to comply with specified performance requirements, while maintaining the basic design concept. The coordination of attachments must be made with the Structural Engineer prior to final design of attachments and coordination of attachments during the sequence of building construction may be necessary in advance of system installation.

C. The system shall be an open-architecture system: Vendor-independent, non-proprietary, computer system and device design based on official and/or popular standards. It shall allow vendors to create add-on products

that increase the system's (or device's) flexibility, functionality, interoperatability, potential use, and useful life. And enables the users to customize and extend a system's (or device's) capabilities to suit individual requirements.

D. System Operation: A fully functioning system providing features such as described below. The Airport requires a full description in the proposal of all options available within the system for an Airport operation whether detailed in the specification or not.

E. The system shall be provided with a synching mechanism so time does not drift between devices. This shall be coordinated with the PARCS system.

F. Space Counting

1. The system shall individually count every space within the project area and shall report its available or occupied status. The System shall monitor and report on individual space use, real time space availability, duration of stay, facility occupancy patterns, parking zone controls, and provide vehicular wayfinding guidance.

2. On Levels 1 and 2 the system shall count the vehicle in the parking space and debit total count of the facility, the level and the row. In addition the system shall utilize License Plate Recognition to tie the vehicle to the parking space utilizing a camera. The counts shall be displayed at end of aisle signs, at the entry to each level, and at the main entrance to the Facility.

3. On Level 3 a ground mounted individual space sensor shall count the vehicle in the parking space and debit the total count of the facility, the level and the row. The counts shall be displayed on end of aisle signs on the third level and the entry to the third level.

4. In the surface parking lots a ground mounted individual space sensor shall count the vehicle in the parking space and debit the total count of the facility, the level and the zone. The east and west surface lots shall be individual zones. The counts shall be displayed at the entry to the east and west surface parking areas from the interior of the parking structure.

5. There shall be two overall “Lot Full” signs at the roadway approaching the main entry plaza. These signs shall be connected to the system and provide vehicles with warning to not enter the parking plaza if the structure is full. This shall take into account the reserved parkers.

6. The system shall transmit count data to both the Airport's Website and the Airport's Mobile Application and other systems. The system shall provide an Application Program Interface (API) and Software Design Kit (SDK) to the Airport.

7. The Vendor shall, as an alternate, provide a narrative and cost for a pre-count system by floor where additional space counts are collected at the entry to the floor. In addition, the logic to reconcile with the gate control at the main entrance and exit for overall space counts.

G. Operational Scenarios

1. The system on Levels 1 and 2 shall utilize license plate recognition to tie a vehicle to a parking space and enable gateless preferred parking zones. Preferred parkers will be registered in the PARC system and the PGS system shall fully integrate into the PARCS and preferred parker database to determine if the license plate of the vehicle parked in the preferred parking space to the PARC system to determine if the vehicle is a preferred parker. If the vehicle is not a registered preferred parker the system shall, at the time of payment, increase the charged parking rate to the preferred parking rate. The preferred parking zone shall be identified by a unique color on the indicator lights. This zone shall be flexible and expandable based on the demand for preferred parking.

2. As an alternate, the system on Levels 1 and 2 shall utilize the license plate recognition to tie a vehicle to a parking space and enable a "Find My Car" system. The system shall utilize the Pay-on-Foot Machines and the Airport's Mobile Application to interface with the user to find their car by locating by license plate number and displaying space location. As an additional alternate, the system shall include LPR cameras entering and exiting the third level and entering and exiting the east and west surface parking lots to enable find my car on the third level and the surface lots.

3. The system shall be integrated with the PARC system and the reserved parker database such that when a reserved parker reserves a space through the Airport's website or mobile application that the facility count shall be deducted to accommodate space for the vehicle somewhere in the parking facility.

4. The system shall track other specialty counting zones in addition to the ones mentioned above such as ADA spaces, 1 hour spaces, EV Charging Spaces etc. The specialty zones shall report on

individual space use, real time space availability, duration of stay, facility occupancy patterns.

H. Other Equipment

1. All equipment system communication boxes shall be located in the Rack Rooms.

2. UPS shall be provided for 30 min. duration and the Vendor shall propose a UPS deployment for approval by the Airport. As an alternate provide the cost for a 60 min. duration.

I. Systems:

1. Provide complete parking guidance system computer and software which operates on an Airport approved Server. Server location to be in Terminal 2 West Server room.

2. System(s) required for PGS shall run as virtualized servers under VMWare. Server hardware for PGS shall be provided per recommendation and approval of hardware specification by Airport Authority IT Department. All applicable licenses shall also be included for the provision of redundant PGS systems using the latest versions of VMWare and all required licenses for Windows Server, database management system, and PGS applications.

3. The interface for the system shall be web based and allow access by identified/authorized users from any device for management, data and reporting.

4. All system equipment shall be subject to the approval of the Airport Authority and be consistent with the SDCRAA IT Infrastructure Standards and Construction Manual v2.3.

5. Recommended list of hardware shall be submitted with proposal.

J. Software

1. All required software shall be listed with the proposal.

2. All software must be provided with an Enterprise license under the Airport's name.

3. If there are ongoing "software as a service" charges these must be identified in the proposal. The cost of the first year is to be included in the pricing. Identify the cost for five years beyond the first year as an alternate.

4. Software upgrades during the warranty period shall be included in the pricing.

5. Future upgrades of software must be fully tested prior to installation and the Airport shall not be the first installation of the software upgrade. The upgrade shall not be mandated but coordinated with the Airport prior to installation. A full description of the upgrade and its impacts on the Airport's entire system shall be provided to the Airport for review and agreement prior to installation. Please describe in your proposal how upgrades, patches and other minor modifications are handled beyond the warranty period.

K. Other:

1. All equipment must be individually IP addressable.

2. System alarms shall send to Parking Management Office and to any authorized user's mobile device.

3. During the initial 1 year warranty and maintenance contract period, if the Airport chooses, Vendor will perform all system programming including but not limited to, setting up new special parking zones.

4. PGS Vendor will be responsible for running all power and data lines from identified junction boxes, panels, and load centers to the equipment and verifying that there is sufficient power to maintain a fully functional system, if necessary.

5. The System shall be fully expandable, and accommodate the addition of equipment and controls for an additional project of similar size on Airport to be built in the future, along with counting in other existing Airport parking lots.

L. Integration:

1. The Parking Guidance System must fully integrate into the Parking Access and Revenue Control System. Please refer to the Parking Access and Control System specification as a reference document. The PGS shall be fully integrated into and shall export data to the PARCS, and import data from PARCS. Data for exchange to include but may not be limited to:

a. License plate information for enforcement. Use license plate information to adjust parking charges when out of compliance. The PARC system shall take data input from the PG system license plate recognition for comparison to the

preferred parking database and if an unauthorized vehicle parks in a preferred parking space the PARC system must charge this vehicle the preferred parking rate at the time of payment.

b. The PARC system count shall provide reconciliation with the PG system count. Parking count data to allow for current and real time exchange of information. Lot full signs shall be run from the PARCS counts to account for reserved spaces. Level Counting signage and End of Aisle signage shall run from the PGS. Reporting from PGS shall be integrated into PARCS reporting.

2. The PG system must provide data, through the PARCS application, that can be accessed through the Airport's website and mobile application. Types of integration include but may not be limited to:

a. Provide real time parking availability counts in coordination with the PARC system. The system shall provide for reconciliation between gates and point of sale counts in the PARC system to assist in determining Lot Full status.

b. The system shall be fully integrated with the web and mobile API's and SDK's of the Airport developer's software.

M. Licenses:

1. All licenses to be co-terminus (end on the same date) and begin on the day of opening of the facility.

2. A list of all licenses and documentation of the co-terminus end dates must be provided as part of the operations and maintenance manuals.

3. The Airport must be listed as the owner of all licenses.

1.3 SUBMITTALS

A. Shop Drawings and Specifications: Submit shop drawings for each item of parking equipment required. Show plans, elevations, dimensions, and details of equipment and other components. Show layout and installation details, including anchorage details and relationship to adjacent building components. Resubmit a specification section for approval.

1. Vendor will be required to provide detailed coordination with Electrical Contractor for the routing and location of conduit that will support the PG system.

2. Submit drawings to include electrical rough in, system zoning, equipment layout, embed and attachment location, power and data feed locations, signage locations, tray and tray limitation details, and camera locations and mounting.

3. Submit wiring diagrams detailing wiring for parking guidance equipment operator, signal, and control systems differentiating clearly between manufacturer-installed wiring and field-installed wiring. Show locations of connections to electrical service provided as a unit of work under other Sections.

4. This specification section will be provided in MSWord format.

5. The base drawings will be provided in Revit/AutoCAD format.

B. Product Data: Submit manufacturer's product data, specifications, and installation and maintenance instructions for each product and piece of equipment required.

1. Provide templates for anchor bolts and other items encased in concrete or below finished surfaces in sufficient time to not delay Work.

C. Maintenance Data and Instructions: Submit for inclusion in Owner's Operation and Maintenance Manual, copies of manufacturer's recommended maintenance procedures, and any special tools required for maintenance.

1. Include instructions for operating computer software system.

2. Include recommended methods and frequency for maintaining equipment in optimum operating condition under anticipated traffic and use conditions.

3. Include precautions against materials and methods that may be detrimental to finishes and performance.

4. Provide parts lists with installed quantity, spare parts list for reordering, schematics for system description.

D. Reports: Provide a sample set of reports and a final set of reports once the custom reports have been established.

E. Service and Warranty Personnel Qualifications: Submit personnel based on the requirements of this section for approval.

F. Test Scripts: Submit test scripts for all testing procedures at least 60 days prior to any testing.

G. Final As-Built Drawings and Specifications in both Revit/AutoCAD and hard copy

1.4 QUALITY ASSURANCE

A. Vendor/Manufacturer Qualifications:

1. The Vendor/Manufacturer of the equipment shall have a minimum of 3 installations of a similar size and complexity in the United States. Similar size and complexity shall mean at least 1500 stalls in a single installation.

2. The Vendor must also have at least 2 installations with a parking access and revenue control system interface of at least 1500 spaces.

B. Installer Qualifications: Shall be experienced in the installation of parking guidance systems, shall show evidence of having successfully completed parking guidance system installations with similar scope and complexity, and recommended by the system manufacturer. Installer must have completed at least 3 projects of similar complexity.

C. The Installer's Project Manager shall have a minimum of three project installations of systems with similar scope and complexity.

D. The PM shall act as the main point of contact with the PARCS Vendor, Contractor and Owner's representatives and shall be responsible for managing and coordinating all aspects of the Work including project management, administration, coordination, and attending regularly scheduled meetings. Project Manager shall provide regular written communication throughout the course of the Work with no less than weekly project status updates from the issue of the Notice to Proceed.

E. The System Manufacturer shall provide a qualified Manufacturer's Technical Representative to participate in the following:

1. Pre-installation meeting with the contractor, system installer, related sub-contractors, owner, and design team.

2. Available during Operational Demonstration testing to resolve issues within 24 hours.

3. Available on site during System Acceptance test.

F. Personnel providing Service and Warranty work for the System shall have factory training, direct and local supervision. The Vendor shall allow the Airport's Operator to provide a factory trained technician to service the equipment without voiding the warranty.

G. Service and Warranty Supervisor shall be trained, approved, and certified by the System Manufacturer, and have a minimum of two years' experience maintaining the System, or similar Systems.

H. Vendor shall provide a QA/QC plan that describes the procedures that will be followed for the installation and testing of the equipment. This plan shall be provided within 30 days of notice to proceed. This plan shall include but is not limited to: coordination procedure for rough in with electrical subcontractor, verification of existing infrastructure and integration components. This document shall be a living document as needed to complete a complete operational system.

I. Should a specific part or piece of the System equipment require repair three (3) or more times within any thirty (30) calendar day period or have accumulated down time of forty-eight (48) or more hours during any thirty (30) calendar day period, that part or piece shall be replaced in its entirety with a new device at the expense of the PGS Vendor.

PART 2 - PRODUCTS

2.1 VEHICLE COUNT SYSTEM.

A. Manufacturer/Supplier: Subject to compliance with requirements, manufacturers offering products which may be incorporated into the Work include the following:

1. Indect Upsolut System

2. Park Assist M4 System

3. Or Equal

B. Sensors:

1. On the first and second levels the sensors shall utilize a camera based technology. The housing color shall be white, or other light color to be coordinated with white painted ceiling.

2. On the third level and in the surface parking lots a ground mounted wireless sensor shall be utilized. These sensors shall transmit parking space status wirelessly through relay nodes to central data collector points, utilizing a self-repairing mesh radio network.

Sensors shall meet IP 67 requirements. Battery life shall be a minimum of 5 years. Solar power may also be considered if it can provide similar level of accuracy and quality.

C. Indicator Lights:

1. Indicator lights shall be 16 RGB LED and shall have multiple colors beyond red and green. The color shall be changed remotely.

D. Mounting:

1. The sensors shall be mounted to a track that is attached to the slab soffit and requires a sleeve through the structural beams. The track shall be mounted as close to the slab as possible. The color of the track shall be white or other light color to coordinate with the white painted ceiling. The track section to be selected by Airport from all available track options.

E. Accuracy:

1. The system shall be accurate to 99% for vehicle counting.

2. For license plate recognition the system shall have a capture rate of 99% and the system shall be accurate to a 95% level for plates that are non-exceptions. That is plates that can be read and are not blocked from view or in other ways not readable. The vendor shall propose a method to determine the measurement of the accuracy of the system to be accepted by the Airport. The testing procedures shall be incorporated as part of the overall PARCS testing procedures.

2.2 SIGNAGE

A. General: Provide real time occupancy data to be displayed as follows:

1. At the end of aisles, at the entrance to each floor and at facility vehicular entrances using LED sign displays. Numbers to be no less than 5" high and display green numbers when spaces are available, and a red "FULL" when aisle/floor level is full. Refer to Signage drawings for additional information and general location of these signs.

2. As an alternate provide 12 full variable message signs to be utilized as part of the preferred parking areas to identify these spaces to preferred parking patrons. These signs shall be approximately 14”x 5 ft. The signs shall be pendant mounted below the beams with the

bottom of the sign no lower than 7 feet above the finished floor to bottom of sign.

B. Features:

1. Display matrix should provide minimum five-inch high alpha-numeric characters and be readable at 200 feet by an individual with 20/20 vision.

2. Display matrix should be viewable in angle 70° vertical and 140° horizontal.

3. Display matrix should be equipped with light sensor and automatic brightness control.

4. Display matrix should be equipped with very bright LED (> 2.5 cd per LED)

C. Sign Quality:

1. PGS Vendor to provide variable message stall number signs to be installed in the housing as specified under the Signage and Wayfinding scopes. This sign will only include the number and not any arrows or other special characters.

2. Structural Steel and Aluminum: The sign case shall be manufactured using 100% extruded aluminum. Sheet aluminum will be a minimum of 1/8-inch thick. Aluminum members will be seamless with continuous welds in the corner. Structural steel supports will be galvanized to prevent rusting.

3. Condensation Removal: Provide thermostatically controlled heater strips, fans, vents or other approved methods are used to keep condensation from forming on the display face(s) of the electronic display.

4. Front Face: The front of the electronic display front face covering must be of an impact resistant, non-glare, polycarbonate with a ultra-violet (UV) inhibitor to protect the pixels from fading and to reduce yellowing of the sign face. The face of the display is easily opened from the front, hinged from the top, and will be held into position by prop bar, gas springs or approved equal. The PGS Vendor shall coordinate with the Signage Vendor and the owner must approve of the layout of the sign face and display before they are manufactured.

5. Back Face: When providing a single-sided display the back face is constructed of aluminum sheeting.

6. Internal Illumination: All electronic displays and static lettering are to be designed with a reflective foil on each sign.

7. Environmental: The message sign operates without any decrease in performance over an ambient temperature range of –30ºF to + 165ºF with a relative humidity of up to 95%; and shall withstand wind pressures to 80 mph.

8. Drawings: Provide message sign cabinet drawings to be submitted to the owner for approval.

9. Housing: Provide rated for NEMA 4 with the door internally gasketed to provide the necessary seal. Provide welded corners for stability and water tightness. Silicone or other sealants will not be allowed to seal joints.

   a. To avoid any corrosion, or dirt intrusion, the door hinge shall be mounted internal to the housing.

   b. Each message sign panel shall be modular in design, and shall be designed to be stacked upon another message sign panel.

2.3 PARKING COUNT MANAGEMENT SYSTEM

A. General: Provide manufacturer's standard software that has open architecture for integration with third party software and provides automatic facility monitoring, supervision, and remote control of parking guidance equipment from one or more locations. The system shall work through a web based interface where all information is readable through any terminal that is connected to the internet and provides a proper password.

B. B. System Performance: The system shall provide the Airport with functionality such as that listed below. Additional functionality that will provide the Airport better customer service options to its patrons will also be considered. Provide all proposed functionality as part of your response.

1. Collect data for comprehensive stall counting and activity reporting system. The PGS must report real time the counting.

2. The system shall be designed so the Operator can override any sign from the central system.

3. The system shall be designed so the Operator can make adjustments to system counts and all field devices from the central system.

4. The system shall monitor its components and provide status alarms of malfunctioning equipment to the Parking Management Office and to any authorized user's mobile device.

5. The system shall provide an alarm status notification to Parking Management Office and to any authorized user's mobile device when a zone, level, or the facility reaches an agreed upon level.

C. The Parking Count Management System shall be expandable to add hardware devices in the future to accommodate a facility of similar size to be built in the future without a major upgrade to the hardware or software within seven (7) years from the date of acceptance of the PARCS. If Vendor anticipates a necessary major upgrade during the next seven (7)-year period, please specify pricing and describe licensing.

D. High and low voltage surge suppression must be included in the installation, as well as an alternate for both a 30 min. and a 60 min UPS battery backup for all computer-related equipment.

E. In the event of a communication interruption, the PGS shall hold counts in a buffer and reset count signs and other devices within an agreed upon duration of time.

F. The PGS Central Computer System shall retrieve buffered counts once communication is restored.

G. Reporting: The system shall provide reports for the Airport's operations. . In addition to the standard reports, the Airport will work with the Vendor to establish up to 10 custom reports during the installation process. The PGS shall generate/query reports which can be set by the parking operator and management users. Please include samples and/or screen shots of all reports in an initial submittal and a sample of all reports as part of the final programming phase. Reporting shall be coordinated through the PARCS system.

H. Workstations: Provide computer, monitor, and peripherals for proper operation of software. Workstations must include password protection. Final selection of hardware subject to Airport approval and the SDCRAA IT Infrastructure Standards Construction Manual v2.3.

I. Data Storage: Shall provide for data storage for a 1 year duration.

2.4 MISCELLANEOUS EQUIPMENT

A. Miscellaneous Fasteners, Anchor Bolts and Templates, Connectors, etc.: As standard with system manufacturer. Hot-dip galvanize anchor bolts and other accessory items in accordance with ASTM A153.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive parking guidance system and conditions under which parking guidance system is to be installed. Correct unsatisfactory surfaces and conditions prior to commencement of installation.

B. All conduits to be located in a concealed condition. No saw cutting of concrete slabs is allowed. All equipment mounting, loop detectors, conduit etc. shall be located by the Vendor prior to concrete pours.

1. Conduits will be run by the Electrical Subcontractor. PGS vendor shall provide rough in drawings for use and provide Quality Control to verify installation.

3.2 INSTALLATION

A. General: Install parking guidance system in accordance with manufacturer's written recommendations, as indicated on the Drawings, and in compliance with requirements of authorities having jurisdiction.

B. Install components plumb, true, securely anchored to adjacent structure, with all equipment, controls, etc., connected, adjusted and ready for use.

C. Track mounting system: Install tracks as close as possible to slab soffit.

D. Connect wiring and ground equipment in accordance with manufacturer's written instructions and requirements of specifications Division 26 - Electrical.

E. The PGS manufacturer must be responsible for power connections to all equipment and must make all necessary communication connections to the central server. Vendor will be responsible for running all power lines from identified junction boxes, panels or breaker boxes to the equipment, if needed. All such communication and conduits that may be required are the responsibility of the Vendor to secure, along with any associated costs. All conduits shall be located in the slab and be coordinated with the Electrical sub-contractor and the structural engineer.

F. Electrical subcontractor will embed j-bolts per PGS rough-in drawings. PGS Vendor to provide Quality Control on installation. PGS vendor shall extend conduit to tray. PGS Vendor shall mount tray, Electrical subcontractor will provide sleeves through beams for tray, PGS Vendor to provide Quality Control on installation.

3.3 CLEANING AND ADJUSTING

A. Clean system components using manufacturer's recommended cleaners.

B. Bring up the system and provide complete operational testing. Provide final field adjustments as may be required to insure proper operation.

C. Validate the back-up and recovery plan.

3.4 TRAINING

A. General: Engage a factory-authorized service representative to organize, schedule and train Owner's maintenance personnel in adjusting, operation and maintenance of the parking control system. Provide training to achieve the following general objectives:

1. Proper operation and adjustment of system.

2. Required programming of the system controller and related devices.

3. Trouble shooting using maintenance and repair manuals.

4. Use of any special tools required for adjustment or repair.

B. The proposal shall allow for training of both Airport personnel and the Airport's Parking Operator personnel. As part of the proposal please provide a description of a proposed training program that allows for up to 3 different types of personnel from management to line personnel to be trained. This would be Familiarization Level Training, User Training and Train the Trainer Training. Please identify the cost of this training as a separate amount. Vendor shall submit a schedule for training for approval one month prior to the start of acceptance testing. Training shall be coordinated with the PARC System and shall be integrated as much as possible.

C. All training shall be on site. Training shall be video-taped and Airport shall be provided a DVD of this for future use.

3.5 TESTING AND COMMISSIONING

A. General: The Airport requires a robust and sound testing and commissioning program for the project. The Airport desires that the system be fully operational at the date of opening of the facility and be fully tested prior to that date.

B. The Vendor shall provide a detailed testing procedure as part of the proposal. Please identify the cost of the testing and commissioning as a separate amount. This can include but may not be limited to:

1. Factory Acceptance Tests. In an offsite location controlled by the manufacturer as close as possible to the jobsite. The purpose of the FAT is to demonstrate the operation and performance of all the equipment components, both online and offline and the configuration of all components and subsystems. At the end of running all the FAT "test scripts", an assessment is made of testing, any gaps identified, and a decision on whether to move forward to the next phase of testing, the LAT. Final test scripts shall be submitted 60 days prior to the test.

2. Operational Demonstration Tests. Once an approved FAT has been completed an onsite operational demonstration test may be conducted. This would include interface with PARCS, the airport's server requirements, signage interface, mobile/web interface etc. For camera based sensors this will include the duration for the sensors to know their environment and calibrate to their location. Final test scripts shall be submitted 30 days prior to the test.

3. System Acceptance Tests. The purpose of which is to ensure that operational testing in a real life environment allows for a period of time to make final system adjustments. After approval of all ODTs a full system 30 day continuous acceptance test shall be conducted to run the entire operation as a whole in concert with the PARCS system.

4. As it is the Airport’s desire to evaluate doing all testing prior to the opening of the facility include a discussion of this in your proposal. Describe the schedule issues and the procedures you would recommend. If there is any additional cost for this testing being done prior to opening include this as an alternate amount. If the testing is not complete prior to opening please describe the accuracy levels of the system that would be achieved on the day of opening.

C. The Vendor shall coordinate the schedule of all testing procedures with the General Contractor's overall construction schedule. They shall actively participate in the creation of tasks within the Contractor's P6 schedule software to identify the critical path for the manufacturing, installation and testing of the system.

D. The Airport has hired an independent commissioning agent for this project to observe and validate the process. The final testing and commissioning plan will be submitted as a deliverable under the final programming phase of the project. This plan is subject to the review and approval of the Airport and the Design Build Team.

3.6 MAINTENANCE AND WARRANTIES

A. General: The standard 1 year Maintenance and Warranty period shall start at the date of facility opening.

B. All warranties shall be co-terminus based on the date of facility opening.

C. The Airport shall be listed on all warranties.

D. The Vendor shall provide factory trained technicians to provide maintenance on the system such that 24 hours a day 7 days a week a person is available. A person shall be on site if necessary within a 12 hour period to resolve any issues. If issues can be resolved remotely a 6 hour response time is required. The Airport expects general resolution to issues within 3 days unless mutually agreed otherwise.

E. Extended warranty and maintenance: As part of the proposal please provide the cost of extended maintenance for a period of five years beyond the initial one year warranty period. Please provide the cost for an extended five year warranty beyond the initial one year warranty period.

END OF SECTION 111200