ABSTRACT: Disclosed are devices, systems and methods for managing parking monitoring and enforcement. In one aspect, an in ground sensor provides a first vehicle detection technique and a video camera employing machine vision provides a second vehicle detection technique. A vehicle detection technique for a smart parking meter utilizes both of the first and second detection techniques to make a highly accurate determination of a vehicle entering a parking space and a vehicle exiting a parking space. The second detection technique can be used to perform a double check on the first technique, or vice versa.

Published:

— with international search report (Art. 21(3))
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
PARKING SPACE DETECTION METHOD AND SYSTEM

PRIORITY

This application claims the priority benefit of U.S. Provisional Application No. 62/246,787, filed on October 27, 2015, which is hereby incorporated herein by reference in its entirety.

FIELD

The present invention relates generally to parking systems and, more particularly, to methods, systems and devices for automatically detecting the presence of a vehicle in a parking space with a high degree of accuracy.

BACKGROUND

Smart parking meter systems have been developed, such as those disclosed in U.S. Pat. Pub. Nos. 2014/0214499 Al and 2014/0214500 Al (which are both incorporated herein by reference in their entirety herein), which can monitor a given parking space for violations and automatically issue a citation electronically if a violation occurs. In order for such smart parking meters to operate automatically, they must have the ability to detect when a vehicle enters and leaves the parking space being monitored. Attempts to use in-ground sensors have been made. Alternatively, attempts have been made to use the images collected by the smart parking meter’s camera(s) to determine vehicle presence. Both methods have drawbacks.

In-ground sensors typically sense magnetic field strength. For example, the sensor is embedded in the roadway above the location where a vehicle would be parked. When a vehicle is parked over the sensor, the magnetic field increases above a pre-set threshold value, which causes the meter to conclude that a vehicle is present in the monitored space.
A vehicle leaving the parking space is determined in the similar, but opposite manner. The magnetic field drops below a pre-set threshold, which is read by the meter as a change of state to indicate a vehicle leaving the monitored space.

Unfortunately, the in-ground magnetic sensors are prone to magnetic bouncing, which is where the magnetic field reading fluctuates due to a variety of factors. For example, a large industrial truck, such as a plow, driving by on the street next to the parking space will cause an increase and then a decrease in the measured magnetic field. This can cause the meter to correspondingly incorrectly determine that the parked vehicle has left the parking space and then re-entered the space. As a result, the vehicle could be issued a ticket even though it never moved. Weather can similarly affect the operation of the magnetic in-ground sensors. Applicant has found that the in-ground magnetic sensors are only about 92-93% accurate.

Employing machine vision using the cameras on the meters poses problems as well. For example, machine vision at night or in rain or snow is less reliable, and sun angles reflecting off of vehicles and shining into the cameras can cause reading anomalies. The cameras can also become covered with snow or dirt, which compromises their ability to read vehicle presence.

Thus, there is a need to provide improved automated vehicle detection systems and methods.

SUMMARY

Disclosed are devices, systems and methods for managing parking monitoring and enforcement. In one aspect, an in-ground sensor provides a first vehicle detection technique and a video camera employing machine vision provides a second vehicle detection technique. A vehicle detection technique for a smart parking meter utilizes both of the first and second detection techniques to make a highly accurate determination of a vehicle entering a parking space and a vehicle exiting a parking space. The second detection technique can be used to perform a double check on the first technique, or vice versa.
The disclosure includes a method of determining whether a vehicle is present in a parking space. The method can include monitoring the parking space with a first vehicle detection technique, monitoring the parking space with a second vehicle detection technique, and concluding that the vehicle is present in the parking space only when both of the first and second vehicle detection techniques indicate that the vehicle is present in the parking space.

The method can further include concluding that the vehicle is not present in the parking space only when both of the first and second vehicle detection techniques indicate that the vehicle is not present in the parking space.

Monitoring the parking space with the first vehicle detection technique can include disposing a magnetic sensor beneath the parking space, and sensing a change in the magnetic field in the parking space with the magnetic sensor. Magnetic field data can be broadcast from the magnetic sensor to a parking meter. The parking meter can include a processor, a memory, and software code stored in the memory. The monitoring of the parking space with the second vehicle detection technique can include performing a machine vision analysis of the parking space with a camera. The machine vision can be a background (foreground) subtraction process performed on video imaged by a video camera. The video camera can be housed inside of the parking meter or can be placed remote from the meter and coupled or networked with the meter.

A conclusion that the state of the vehicle has not changed can be reached when one of the first and second vehicle detection techniques indicates that the vehicle is not present in the parking space and the other of the first and second vehicle detection techniques indicates that the vehicle is present in the parking space.

The parking space can be monitored for a change of vehicle state for a predetermined length of time, and a conclusion that the vehicle state has changed can be reached only if a monitored parking space state change persists for the entire predetermined length of time.
A measured result of the monitoring can be compared against a hysteresis threshold, and a determination made that the state of the vehicle in the parking space has changed only if the measured result is above the hysteresis threshold.

The disclosure further includes a parking space monitoring system. The system can include a first parking sensor disposed within a parking space and configured to sense a change of state due to a vehicle entering or leaving the parking space, a second parking sensor disposed adjacent to the parking space, the second parking sensor comprising a video camera oriented to image video of at least a portion of the parking space, and a parking meter coupled to the video camera. The parking meter can include a processor, a memory and software code stored in the memory that are all disposed within a housing of the parking meter. The software code is executable by the processor and provides for the parking meter to receive a reading from the first parking sensor that is broadcast to the parking meter. The reading can be stored in memory. The processor can perform a machine vision analysis of the imaged video from the camera to determine whether the vehicle has entered or left the parking space. The processor can be configured to evaluate the reading from the first parking sensor to determine whether the vehicle has entered or left the parking space. The processor can be configured to conclude that a vehicle has entered or left the parking space only if the determinations of the machine vision analysis and the reading from the first parking sensor are in concordance.

The parking meter can be disposed adjacent to the parking space and the video camera is disposed within the housing of the parking meter. The parking meter can include an infrared light oriented to illuminate the parking space during imaging by the video camera.

The first parking sensor can be configured to read a magnetic field strength in the parking space. The first parking sensor can be disposed in the road, pavement or surface underneath the parking space, or the sensor can be embedded in a nearby structure, such as a curb adjacent to the parking space. The first parking sensor can broadcast its reading to the parking meter via a Bluetooth or other wireless communication protocol, and the meter is configured to receive such broadcast.
The processor in the meter can be further configured to determine whether the vehicle has entered or left the parking space via the machine vision analysis only upon a determination of state that persists for at least a predetermined period of time.

The disclosure also includes a parking meter that includes a housing disposed atop a pole. A video camera can be disposed within the housing and aimed towards a parking space adjacent to the parking meter such that the video camera can image video of at least a portion of the parking space. A processor, memory and software code stored in the memory can each be disposed within the housing. The software code is executable by the processor, which configures the processor to perform a background subtraction analysis on a portion of the imaged video from the camera to determine whether a vehicle has entered or left the parking space.

The processor can also be configured by the software code to determine whether the vehicle has entered or left the parking space via the background subtraction analysis only upon a determination of state that persists for at least a predetermined period of time. The processor can be further configured by the software code to determine whether the vehicle has entered or left the parking space via the background subtraction analysis only upon finding a concordance with a determination of state based upon data from a parking sensor that is separate from the video camera.

The above summary is not intended to limit the scope of the invention, or describe each embodiment, aspect, implementation, feature or advantage of the invention. The detailed technology and preferred embodiments for the subject invention are described in the following paragraphs accompanying the appended drawings for people skilled in this field to well appreciate the features of the claimed invention. It is understood that the features mentioned hereinbefore and those to be commented on hereinafter may be used not only in the specified combinations, but also in other combinations or in isolation, without departing from the scope of the present invention.
BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B are front and back views, respectively, of a smart parking meter according to certain example embodiments.

FIG. 2 is a diagram of a vehicle in a parking space being monitored by a smart parking meter according to certain example embodiments.

FIG. 3 is another diagram of a vehicle in a parking space being monitored by a smart parking meter according to certain example embodiments.

FIG. 4 is an image of a parking space being detected for the presence of a vehicle according to certain example embodiments.

FIG. 5 is another image of a parking space being detected for the presence of a vehicle according to certain example embodiments.

FIG. 6 is a vehicle detection algorithm logic diagram according to certain example embodiments.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the particular example embodiments described. On the contrary, the invention is to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION

In the following descriptions, the present invention will be explained with reference to various exemplary embodiments. Nevertheless, these embodiments are not intended to limit the present invention to any specific example, environment, application, or particular implementation described herein. Therefore, descriptions of these example embodiments are only provided for purpose of illustration rather than to limit the present invention.
Referring to FIGS. 1A, IB, 2 and 3, smart parking meters 100, such as those disclosed in U.S. Pat. Pub. Nos. 2014/0214499 Al and 2014/0214500 Al (which are both incorporated herein by reference in their entirety herein), can be deployed adjacent to various parking spaces. Such smart meters can include one or more cameras 102 arranged to monitor parking spaces 104 adjacent to the meter. The cameras 102 can be configured to capture video or still images.

As explained in U.S. Pat. Pub. No. 2014/0214499 Al, the meters 100 include microprocessors, memory and computer code that enable the meters to monitor parking events, including determining the presence of a vehicle 105 in a parking space 104, determining the identity of the vehicle, permitting the parking user to pay for parking time, determining parking violation notices, and other intelligent functions.

A computer readable program code can be stored in the physical memory (e.g., random access memory, flash memory or hard-drive) of the meter. The computer readable program code is configured such that when executed by the microprocessor, the code causes the meter to perform the steps of the invention described herein.

Referring to FIGS. 1A and IB, each parking meter in certain embodiments includes an enclosure 108 mounted atop a pole 110. The housing 108 includes the electronics components mentioned above. In addition, the housing includes, on the front side, a speaker 112, front-facing camera 114 and microphone 116 disposed adjacent to the graphical user interface (e.g. touch screen) 118. A payment acceptance means 120 and coin slot 122 are also provided. The payment acceptance means can be a contactless or conventional card reader, or other known means for accepting payment.

The rear side of the housing 108 includes a plurality of violation indicator lights 124 windows through which the cameras 102 can see, infra red (IR) illuminators 126 to provide an IR light to aid the cameras’ sight, and a lock mechanism 128 to keep unwanted persons from opening the housing 108.

Each of the meters 100 can also be networked with a central or control computer for added control and functionality as explained in U.S. Pat. Pub. No. 2014/0214499 Al.
Further, one smart meter 100 can be networked with one or more remote cameras disposed adjacent to additional parking spaces so that one meter can monitor several different parking spaces and parking events.

The same or similar smart parking meter 100 can also be configured as a kiosk and placed adjacent to a parking lot or ramp to monitor entry and exit events at a lot or ramp as explained in U.S. Pat. Pub. No. 2014/0214500 Al. A kiosk can also simultaneously function as a parking space meter. A single kiosk or meter can further be coupled to one or more remote cameras that each monitor individual parking spaces so that the single kiosk or meter monitors multiple individual parking spaces or events throughout a lot, ramp or street segment.

Note that when the term meter is used throughout this application, such use should be understood to include both smart meters and kiosks.

Referring now to FIGS. 2-3, the smart parking meter 100 includes a camera 102 to view a portion of a vehicle when the vehicle 105 is located in the parking space 104 being monitored. In FIG. 2, the rear side of the vehicle 105 is being viewed by the camera 102. In FIG. 3, the front side of the vehicle 105 is monitored by the camera 102.

In addition, an in-ground sensor 106 is embedded in the road underneath the vehicle 105 when the vehicle is present in the parking space 104. The in-ground sensor 106 can also be located in alternative positions such as in the curbing.

The in-ground sensor 106 is preferably a magnetic sensor. The sensor can be disc-shaped to facilitate embedding in the roadway. The sensor 106 can alternatively perform sensing of the vehicle using other means such as radar.

The in-ground sensor 106 broadcasts a status message to the nearby meter 100 as shown in FIG. 3. The broadcast can be performed using low power Bluetooth or other short range wireless communications protocol. The broadcast frequency can be continuous or periodic. For example, the status of the in-ground sensor 106 can be broadcast once per second, ten times per second, etc.
In one preferred embodiment, the magnetic in-ground sensor 106 is powered by an internal lithium-based battery and a sensing/broadcast cycle is performed once per second in order to conserve battery life. A sensor life expectancy of several years can be achieved using such battery and operating method. In other embodiments, the in-ground sensor can be hard-wired for power and/or broadcast.

The cameras or optical sensors 102 disposed in the parking meter (or remotely from the meter housing as discussed above) use image sensors (e.g., ccd or cmos) and apply a background subtraction methodology to determine whether a vehicle 105 has entered or left the parking space 104. Note that the background subtraction methodology can also be referred to as foreground subtraction and foreground detection.

In particular, the vehicle status determination protocol is based upon monitoring a segment or window of the image sensor’s viewed image. Referring to FIG. 4, a monitored window portion 130 in the lower right quadrant of the total captured image is designated for monitoring as part of the background subtraction technique. Detected objects can also be color-coded on the viewer’s screen (at central control) to quickly note progress and lock status.

Note that the in-ground sensor 106 can be seen as a disc-shaped object in FIG. 4 embedded in the roadway.

Now referring to FIG. 5, a vehicle is present in the view of the image sensor, and the background subtraction image processing technique is resolving whether a vehicle is present based upon the monitored window portion 130 in the lower left quadrant. The frequency of the background subtraction monitoring employed can be varied. For example, each processor clock cycle, or some other less frequent evaluation can be performed. The result of the background subtraction evaluation is a determination of a state change (e.g., a vehicle entered an open space, or a vehicle left an occupied space).

Next, the overall vehicle detection algorithm is employed. The detection algorithm, method and technique combine data from the in-ground sensor 106 and from the camera 102. FIG. 6 provides a detailed step-by-step breakdown of the algorithm and method.
First, the overall magnetic field strength "sum" is read from the in-ground sensor 106 in step 200 along with the magnetic field strength in the "z-axis" (vertical direction normal to the parking surface). Then in steps 202 and 203, it is determined by the magnetic sensor 106 whether the parking space 104 has been vacated and stayed vacant for more than 15 seconds. If yes, then the state of the camera-based computer vision (image sensing algorithm - referred to as "Unicorn" in FIG. 6) is set to a "departed" state. But if the determination by the data provided by the in-ground magnetic sensor 106 is no and the magnetic field reading is above a pre-set threshold in step 204, then the current state of the parking space is determined to be occupied.

Next, a series of double check queries are performed by the processor in the parking meter as part of the algorithm to ensure that no false positive or false negative state determinations have been made by the in-ground sensor 106. A query 206 is performed to confirm that the magnetic sensor's Z-axis reading is greater than a pre-set threshold. The processor also determines whether the magnetic sensor's Z-axis flag is on 208, whether the Z-axis reading is above a hysteresis threshold 209, whether the Sum value is above a hysteresis threshold 210, whether the low energy flag has been set to "on" 211 and 212, whether the Sum value is greater than a low low hysteresis threshold 213, whether the Z-axis value is less than a low hysteresis threshold 214 and whether the Sum value is lower than the low low hysteresis threshold 215. These queries by the processor check various parameters and states of the in-ground sensor's 106 readings and state to ensure that a valid parking space state change is being set by the overall system.

Next, the processor performs a series of queries involving the machine vision evaluation of the parking space to ensure that a conclusion regarding the occupancy state of the parking space being evaluated is reached with a high degree of certainty. In FIG. 6, if the machine vision detection determines that the space is occupied by a vehicle 230, then the Sum value sensed by the magnetic sensor 106 is evaluated to see if it is over a 100 click threshold 216 and it is determined whether the machine vision is in a locked status 217. Next, if the machine vision detection determines that the space is not occupied by a vehicle 232, then the machine vision analysis is evaluated to a pre-locked status 218 and the Sum
value sensed by the magnetic sensor 106 is evaluated to see if it is above the low low hysteresis threshold 219.

The determinations for parking space locking 220 and pre-locking are also explained in FIG. 6. Once the machine vision detects that the space is occupied 234, a positive lock status 220 is changed to unlocked. If the current conclusion of the system is that the parking space state is occupied 236 and the samples taken by the machine vision analysis are above a pre-set threshold 221 and above that threshold plus one, then the status is set to pre-locked.

The queries above are double-checks to using the machine vision evaluation to ensure that the determination made from the in-ground sensor is confirmed. If any of these double-check queries fails to confirm the initially determined state, then the current state is changed 223 and the algorithm iterates again. The specific outcome of these determinations described above is provided in FIG. 6.

A vehicle is determined to be arriving 224 if the current state is "occupied" and a subsequent valid iteration of the algorithm determines that the state has changed from "unoccupied" to "occupied". The reverse is true for determining a vehicle departure 226.

By combining the state determinations and sensing data from both the in-ground sensor 106 and the machine vision analysis using the image sensor 102, a high degree of confidence can be formed for achieving the correct state of vehicle occupancy in a parking space. Thus, the occurrence of false readings as compared to the conventional techniques can be greatly reduced or eliminated. Reducing false readings ensures that parking revenue is maximized and that there is no false issuance of parking tickets and the ill will associated with the same.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it will be apparent to those of ordinary skill in the art that the invention is not to be limited to the disclosed embodiments. It will be readily apparent to those of ordinary skill in the art that many modifications and equivalent arrangements can be made thereof without departing from
the spirit and scope of the present disclosure, such scope to be accorded the broadest interpretation of the appended claims so as to encompass all equivalent structures and products. Moreover, features or aspects of various example embodiments may be mixed and matched (even if such combination is not explicitly described herein) without departing from the scope of the invention.
CLAMS

What is claimed is:

1. A method of determining whether a vehicle is present in a parking space, the method comprising:
   - monitoring the parking space with a first vehicle detection technique;
   - monitoring the parking space with a second vehicle detection technique; and
   - concluding that the vehicle is present in the parking space only when both of the first and second vehicle detection techniques indicate that the vehicle is present in the parking space.

2. The method of claim 1, further comprising concluding that the vehicle is not present in the parking space only when both of the first and second vehicle detection techniques indicate that the vehicle is not present in the parking space.

3. The method of claim 1, wherein the step of monitoring the parking space with the first vehicle detection technique comprises:
   - disposing a magnetic sensor beneath the parking space; and
   - sensing a change in the magnetic field in the parking space with the magnetic sensor.

4. The method of claim 3, further comprising: broadcasting a magnetic field data from the magnetic sensor to a parking meter, wherein the parking meter includes a processor, a memory, and software code stored in the memory.

5. The method of claim 3, wherein the step of monitoring the parking space with the second vehicle detection technique comprises performing a machine vision analysis of the parking space with a camera.

6. The method of claim 1, wherein the step of monitoring the parking space with the second vehicle detection technique comprises performing a machine vision analysis of the parking space with a camera.
7. The method of claim 1, further comprising concluding that a state of the vehicle has not changed when one of the first and second vehicle detection techniques indicates that the vehicle is not present in the parking space and the other of the first and second vehicle detection techniques indicates that the vehicle is present in the parking space.

8. The method of claim 1, wherein the step of monitoring the parking space with a first vehicle detection technique includes:

- monitoring the parking space for a change of vehicle state for a predetermined length of time; and

- concluding that the vehicle state has changed only if a monitored parking space state change persists for the entire predetermined length of time.

9. The method of claim 1, wherein the step of monitoring the parking space with a second vehicle detection technique includes performing a background subtraction operation on a video feed of a camera trained on the parking space.

10. The method of claim 1, wherein at least one of the steps of monitoring the parking space with the first and second vehicle detection techniques includes:

- comparing a measured result against a hysteresis threshold; and

- determining that a state of the vehicle in the parking space has changed only if the measured result is above the hysteresis threshold.

11. A parking space monitoring system, comprising:

- a first parking sensor disposed within a parking space and configured to sense a change of state due to a vehicle entering or leaving the parking space;

- a second parking sensor disposed adjacent to the parking space, the second parking sensor comprising a video camera oriented to image video of at least a portion of the parking space;

- a parking meter coupled to the video camera, the parking meter including a processor, a memory and software code stored in the memory that are all disposed within a housing of the parking meter, the software code being executable by the processor,
wherein the first parking sensor is configured to broadcast a reading to the parking meter and the parking meter is configured to receive the reading and store the reading in the memory,

wherein the processor is configured to perform a machine vision analysis of the imaged video from the camera to determine whether the vehicle has entered or left the parking space,

wherein the processor is configured to evaluate the reading from the first parking sensor to determine whether the vehicle has entered or left the parking space, and

wherein the processor is configured to conclude that a vehicle has entered or left the parking space only if the determinations of the machine vision analysis and the reading from the first parking sensor are in concordance.

12. The system of claim 11, wherein the parking meter is disposed adjacent to the parking space and the video camera is disposed within the housing of the parking meter.

13. The system of claim 12, wherein the parking meter includes an infrared light oriented to illuminate the parking space during imaging by the video camera.

14. The system of claim 11, wherein the first parking sensor is configured to read a magnetic field strength in the parking space.

15. The system of claim 11, wherein the first parking sensor is embedded in a road surface of the parking space.

16. The system of claim 11, wherein the first parking sensor broadcasts the reading to the parking meter via a Bluetooth communication protocol, and wherein a Bluetooth receiver is included within the housing of the parking meter and coupled to the processor.

17. The system of claim 11, wherein the processor is further configured to determine whether the vehicle has entered or left the parking space via the machine vision analysis only upon a determination of state that persists for at least a predetermined period of time.
18. A parking meter, comprising:
   a housing disposed atop a pole;
   a video camera disposed within the housing and aimed towards a parking space adjacent to the parking meter such that the video camera can image video of at least a portion of the parking space; and
   a processor, a memory and software code stored in the memory that are each disposed within the housing, the software code being executable by the processor,
   wherein the processor is configured by the software code to perform a background subtraction analysis on a portion of the imaged video from the camera to determine whether a vehicle has entered or left the parking space.

19. The parking meter of claim 18, wherein the processor is further configured by the software code to determine whether the vehicle has entered or left the parking space via the background subtraction analysis only upon a determination of state that persists for at least a predetermined period of time.

20. The parking meter of claim 18, wherein the processor is further configured by the software code to determine whether the vehicle has entered or left the parking space via the background subtraction analysis only upon finding a concordance with a determination of state based upon data from a parking sensor that is separate from the video camera.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G08G1/14 (2016.01)
CPC - G08G1/14, G06K/141

According to International Patent Classification (IPC) or to both national classification and IPC

B. DOCUMENTS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classifications: G08G1/14, G07F17/24, G06K7/78, G07B15/02 (2016.01)
CPC Classifications: G08G1/14, G08G1/141, G07F17/24, G06G1/146, G06K9/00812, G07B15/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSear (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, Other Countries (INPADOC), RU, AT, CH, TH, BR, PH);
Google/Google Scholar; IEEE/IEEEXPLORE; EBSCO Non-Patent Prior Art Source; KEYWORDS: parking, space, vehicle, state, time, broadcast, receiver, meter, sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 2015/0138001 A1 (IMAGEMAKER DEVELOPMENT INC.) 21 May 2015; Figures 3, 4; Paragraphs [0039], [0040], [0049], [0060], [0119], [0124]</td>
<td>1, 2, 6-13, 16, 17</td>
</tr>
<tr>
<td>Y</td>
<td>CA 2,567,464 A1 (VEHICLE MONITORING SYSTEMS PTY LTD, AU) 24 November 2005; Page 4 lines 20-34, Page 6 lines 8-16, Page 13 lines 4-9</td>
<td>3-5, 14, 15</td>
</tr>
<tr>
<td>A</td>
<td>WO 2015/118084 A1 (PARK24) 13 August 2015; entire document</td>
<td>1-17</td>
</tr>
<tr>
<td>A</td>
<td>US 2001/0012241 A1 (DEE, M et al.) 09 August 2001; entire document</td>
<td>1-17</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
  * "A" document defining the general state of the art which is not considered to be of particular relevance
  * "E" earlier application or patent but published on or after the international filing date
  * "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  * "O" document referring to an oral disclosure, use, exhibition or other means
  * "P" document published prior to the international filing date but later than the priority date claimed

X later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
Y document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
V document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
A document member of the same patent family

Date of the actual completion of the international search: 15 December 2016 (15.12.2016)

Date of mailing of the international search report: OMAR 2017

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Authorized officer: Shane Thomas
PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)
INTERNATIONAL SEARCH REPORT

PCT/US 16/59081

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: [H] because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Group I: Claims 1-17; Group II: Claims 18-20

---Continued on extra sheet---

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-17

Remark on Protest

- The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

Form PCT/ISA/2 to (continuation of first sheet (2)) (January 2015)
Continued from Box No. III - Observations where unity of invention is lacking.  -

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-17 are directed towards concluding whether a vehicle has entered or left only when both a first and second vehicle detection technique are in concordance.

Group II: Claims 18-20 are directed towards a housing disposed atop a pole in which a processor performs background subtraction analysis to determine whether a vehicle has entered or left.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I include at least a method and system using a first and second vehicle detection technique; and concluding that the vehicle is present only when both of the first and second vehicle detection techniques indicate that the vehicle is present in the parking space, which are not present in Group II.

The special technical features of Group II include at least a housing disposed atop a pole in which a processor is configured to perform a background subtraction analysis on a portion of the imaged video to determine whether a vehicle has entered or left the parking space, which are not present in Group I.

The common technical features shared by Groups I-II are a parking meter; a processor, a memory and software code stored in the memory that are each disposed within the housing, the software code being executable by the processor, a video camera oriented to image video of at least a portion of the parking space; and determining a vehicle is entering or leaving a parking space.

However, these common features are previously disclosed by US 2015/0138001 A1 to IMAGEMAKER DEVELOPMENT INC. hereinafter ("ImageMaker"). ImageMaker discloses a parking meter (automated system for managing parking spaces (parking meter); Abstract); a processor, a memory and software code stored in the memory that are each disposed within the housing, the software code being executable by the processor (processor 144, program memory 145, and modules 138, 139, 143, 116, and 132 (software code stored in the memory/ executable by the processor) all depicted as being included in the computer of system 99 (housing); Figure 4), a video camera oriented to image video of at least a portion of the parking space (license plate recognition module uses collected information from a camera (video camera) capturing high speed images of the vehicle license plate (a portion of the parking space); Figure 1; Paragraphs [0046], [0080]); and determining a vehicle is entering or leaving a parking space (vehicle detection and recognition system 101 collects proximity and motion information, and using the motion detected in different directions, determining the vehicle is entering or leaving the parking space; Figures 3, 4; Paragraphs [0039], [0046], [0090]).

Since the common technical features are previously disclosed by the ImageMaker reference, these common features are not special and so Groups I-II lack unity.