

SYSTEM, APPARATUS AND METHOD FOR VEHICLE PARKING MANAGEMENT

5 TECHNICAL FIELD OF THE INVENTION

The invention relates to a system, apparatus and method for vehicle parking management, and in particular, vehicle detection, vehicle identification, and parking fee collection.

10 BACKGROUND OF THE INVENTION

The following discussion of the background to the invention is intended to facilitate understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known or a part of the common
15 general knowledge in any jurisdiction as at the priority date of the application.

Charging or billing for vehicle parking has been changing over the years. "Coupon parking" requires a vehicle rider to display valid parking coupons (e.g., on the front windscreen or window on the driver's side) to pay for the
20 parking charges at the vehicle parks. Vehicle park wardens are deployed to conduct regular checks on the vehicles parked in the vehicle parks. The "coupon parking" system is troublesome and prone to errors: for example, manual checking of the coupons by vehicle park wardens is labour-intensive; and at the time of parking, the driver might run out of coupons, or simply
25 forget to display the coupons.

A more advanced parking fee collection system comprises an entry station and an exit station. Drivers typically insert a payment card (e.g., stored value card, debit card, credit card) into the entry station to enter the vehicle park.
30 The entry record will then be sent to a control PC. Upon exit, drivers typically insert the same payment card into the exit station. The information collected at the exit station will then be matched with the entry record to tabulate the

parking fee. The calculated parking fee will then be debited from the payment card from a payment collection terminal in the exit station. A gantry barrier will be open after a successful deduction and the payment card is removed from the exit station. Electronic Parking System (EPS) goes one step further to
5 enhance the driver's convenience – on entry to (or exit from) the carpark, the drivers no longer need to stop the car to insert the payment card to register its entry time (and/or exit time). A receiver (such as an antenna) at an exit lane will read the In-Vehicle Unit (IU) (also known as "On-board Unit" (OBU)). Upon successful reading of the IU, the system will store the information in a
10 database and lift up the entry barrier so that the vehicle can enter (or exit). The deduction of the fee is done using the IU in the car. This automatic deduction of fees cuts down the time required by the driver to clear the exit.

Nevertheless, there are still challenges. The current parking fee collection
15 system requires the installation of gantry barrier systems (e.g., comprising entry and exit stations), where the vehicle information (e.g., time of entry, time of exit, details of the payment card, details of the IU, particulars of the driver) can be collected for calculation and payment of parking fee. Such gantry-based vehicle park may face one or more of the following technical problems:

- 20 1. the installation, operation and maintenance of the gantry barrier systems incur significant costs.
2. As vehicles typically stop at the entry and exit gantries and wait for the barriers to be raised, having gantry barrier systems inevitably delays the traffic movement in the vehicle park, and causes congestion during
25 peak hours.
3. As the current gantry-based systems cannot automatically determined the precise location of the parking vehicles, it is troublesome, if not impossible, to impose different parking fee schemes for different parking spaces. In many vehicle parks, the allocation of parking spaces
30 is typically first-come-first-serve, causing crowdedness at convenient locations and underutilization at inconvenient parking spaces.

4. Furthermore, if any error occurs at the gantry system or the IU, the vehicle driver has to stop the vehicle at the gantry barrier to resolve the problem, which might worsen traffic delay and congestion in the vehicle park, particularly during peak hours.

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Thus, there exists a need to develop a vehicle parking management system that at least alleviates some of the technical problems identified above.

SUMMARY OF THE INVENTION

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Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

- 15 Throughout the specification, unless the context requires otherwise, the word “comprise” or variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

- 20 Throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including”, will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

- 25 Throughout the description, the term “in-vehicle unit” (IU) is used to refer to any communication device or module which may be used within a vehicle. IU may be a stand-alone piece of hardware equipment fixed in the vehicle or removable from the vehicle, or alternatively the functionality of the IU may be integrated with other in-vehicle equipment (e.g., a vehicle audio system or a
30 satellite navigation unit) or other external electronic devices such as mobile phone (e.g., smart phone), tablet, personal digital assistant, or laptop. An IU can be equipped with multiple communication functionalities, examples of

which include, not limited to, BLUETOOTH™, WiFi, ZigBee and cellular networks including but not limited to 2G/3G/4G networks.

Throughout the description, the term “vehicle communication device” refers to
5 any electronic device that (i) a user (e.g., driver) can carry or (ii) is installed
inside a vehicle to communicate with one or more communication devices. An
example of the vehicle communication device is the IU. Another example of
the vehicle communication device is a smart phone installed with one or more
software applications, also known as mobile ‘apps’ that is operable to store
10 information of drivers and/or vehicles, as well as to communicate such
information with other communication devices.

Throughout the description, the term “base station” refers to any electronic
device installed at a location (e.g., inside a vehicle park) to communicate with
15 one or more communication devices. A base station can be equipped with
multiple communication functionalities, examples of which include, not limited
to, BLUETOOTH™, WiFi, ZigBee and 2G/3G/4G networks.

Throughout the description, the term “identifier” refers to any information/data
20 that can be utilized to identify a vehicle. An identifier may be a word, number,
letter, symbol, or any combination of those. Examples of identifier include, but
not limited to, vehicle plate number of the vehicle, vehicle colour, vehicle
model, vehicle driver’s particulars (e.g., name, driver license number), or any
combination thereof. The term “identifier” could also refer to a collection of
25 multiple identification information/data. For example, in some embodiments,
the identifier only comprises vehicle plate number; in some other
embodiments, the identifier comprises a plurality of identification
information/data, including vehicle plate number, vehicle colour, vehicle model
and vehicle drivers’ particulars.

30 Throughout the description, the term “validation module” refers to any
hardware device or software module capable of comparing two or more sets

of identification information/data (e.g., two or more identifiers) regarding a vehicle or a driver to determine whether there is any discrepancy between the two or more sets of identification information/data.

- 5 In accordance with an aspect of the present invention, there is a vehicle parking management system comprising: a detection sensor operable to detect a presence of a vehicle at a location, and to obtain a first set of identification information of the vehicle, a base station operable to communicate with a vehicle communication device to receive a second set of
10 identification information of the vehicle after the detection sensor detects the presence of the vehicle at the location, a validation module configured to compare the first identifier with the second identifier to determine whether there is any discrepancy between the first identifier and the second identifier, wherein the detection sensor, the base station and the validation module are
15 configured to be in data communication.

Preferably, the detection sensor is an image-capturing device.

- Preferably, the vehicle parking management system of claim 1 or claim 2,
20 wherein the base station and the vehicle communication device are both BLUETOOTH devices.

- Preferably, the first identifier comprises vehicle plate number, vehicle color, vehicle model, or any combination thereof.
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Preferably, the second identifier comprises vehicle plate number, vehicle color, vehicle model, vehicle IU number, vehicle owner's name, or any combination thereof.

- 30 Preferably, the vehicle parking management system further comprises a parking timer configured to start timing once the validation module determines

that there is no discrepancy between the first identifier and the second identifier.

5 Preferably, the base station is configured to repeatedly communicate with the vehicle communication device at every predetermined time interval, and the parking timer is configured to stop timing once the base station fails to communicate with the vehicle communication device.

10 Preferably, the vehicle parking management system further comprises a toll calculator arranged to be in data communication with the parking timer.

Preferably, the vehicle communication device is arranged to be in data communication with a toll payment terminal.

15 Preferably, the validation module is operable to send an alert message to a vehicle park manager.

20 Preferably, the vehicle parking management system further comprises a database configured to store the first identifier and the second identifier.

In accordance with another aspect of the present invention, there is a method for managing a vehicle park, comprising steps of: (a) detecting a presence of a vehicle at a location and obtaining a first set of identification information of the vehicle by a detection sensor, (b) activating a base station by the detection sensor to communicate with a vehicle communication device to receive a second set of identification information of the vehicle, and (c) comparing the first identifier and the second identifier by a validation module to determine whether there is any discrepancy between the first identifier and the second identifier.

30 Preferably, the method further comprises a step (d) of activating a parking timer to start timing, if there is no discrepancy detected in the step (c).

Preferably, the method further comprises a step (e) of repeating the step (a), the step (b) and the step (c), if there is at least one discrepancy detected in the step (c).

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Preferably, the method further comprises a step (f) of transmitting a first alert message by the validation module to a vehicle park manager, if the step (e) has been repeated a predetermined number of times.

- 10 Preferably, the method further comprises a step (g) of activating the base station to repeatedly communicate with the vehicle communication device at every predetermined time interval.

- 15 Preferably, the method further comprises a step (h) of stopping the parking timer, if the base station fails to communicate with the vehicle communication device in the step (g).

- 20 Preferably, the method further comprises a step (i) of detecting the presence of the vehicle by the detection sensor, if the base station fails to communicate with the vehicle communication device in the step (g).

- 25 Preferably, the method further comprises a step (j) of stopping the parking timer, if the detection sensor fails to detect the presence of the vehicle at the step (i).

Preferably, the method further comprises a step (k) of transmitting a second alert message to the vehicle park manager, if the detection sensor detects the presence of the vehicle at the step (i).

- 30 Preferably, the method further comprises a step (l) of calculating a parking time duration by the parking timer.

Preferably, the method further comprises a step (m) of calculating a toll for the vehicle based on the parking time duration by a toll calculator.

5 Preferably, the method further comprises a step (n) of making payment for the toll at a toll payment terminal.

Other aspects of the invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

10 The present invention provides a gantry-free/gantry-less and yet reliable vehicle park management system over prior art that in general require installation of gantry barrier systems for calculation and collection of vehicle parking fee. The "dual-detection" arrangement, comprising a presence
15 detection sensor for detecting presence of vehicles, a base station for communicating with vehicle communication devices and a validation module for comparing vehicle identifiers obtained from different sources, maximizes accurate detection and identification of a specific vehicle at a specific location (e.g., a particular parking space) so that more fine-tuned parking fee schemes can be adopted to facilitate efficient use of the vehicle park (e.g., higher tolls
20 for convenient lots, lower tolls for inconvenient lots), as well as to increase the revenue of park owner. In particular, the validation module of the present invention can effectively identify system errors or possible frauds by comparing the identifiers separately collected from the detection sensor and the base station, so that the vehicle park management can be timely alerted to
25 address the problems, avoiding unnecessary disputes later on.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

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Figure 1 shows an illustrative view of an embodiment of the vehicle parking management system.

Figure 2 shows a photograph of three vehicles captured by an image-capturing device (i.e., an embodiment of the detection sensor).

- 5 Figure 3 shows a photograph of a park surveillance camera (i.e., an embodiment of the detection sensor) capable of capturing images of multiple vehicles.

Figure 4 is an illustrative flowchart of an embodiment of the method for managing a vehicle park.

- 10 Figure 5 is an illustrative flowchart of another embodiment of the method for managing a vehicle park.

Figure 6 shows an embodiment of the validation module.

- Other arrangements of the invention are possible and, consequently, the
15 accompanying drawings are not to be understood as superseding the generality of the preceding description of the invention.

DETAILED DESCRIPTION

- 20 Particular embodiments of the present invention will now be described with reference to the accompany drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as
25 commonly understood by one or ordinary skill in the art to which the present invention belongs. Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

- In accordance with an aspect of the invention there is a vehicle parking
30 management system 100 operable to detect presence of a vehicle 112, retrieve identifiers of the vehicle via at least two different means, and validate the identity of the vehicle by comparing the identifiers retrieved from the at

least two different means. Examples of the identifier includes, but not limited to, vehicle plate number, in-vehicle unit (IU) identification number, vehicle colour, vehicle logo, vehicle model, driver license number, driver particulars, or any combination thereof.

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As illustrated in Figure 1, the vehicle parking management system 100 comprises a detection sensor 102 operable to detect presence of the vehicle 112 at a location 110. Examples of such location include, but not limited to, parking space, parking lane, any type of vehicle parking space or anything
10 equivalent. Other examples of such location include, but not limited to, gasoline station, industrial facility, commercial enterprise, residential area, street, school, hospital, camp, natural parks and entertainment parks.

Detection Sensor 102

The detection sensor 102 is a device that is configured to detect presence of
15 vehicles and sends the information (e.g., a vehicle is present at a parking space) to a computer processor. In some embodiments, the detection sensor 102 is an image-capturing device (e.g., camera) operable to capture still and/or video images. In some embodiments, the image-capturing device integrates a memory device (e.g., random access memory (RAM), hard disk,
20 flash memory, compact flash (CF) card, secure digital (SD) card, smart media (SM) card, multimedia card (MMC), or memory stick) for storing the captured still and/or video images.

In some embodiments, the image-capturing device detects a vehicle moving into (or out of) a parking space such as a lot/lane by comparing a stream of
25 images captured in sequence over a predetermined period. In some embodiments, the image-capturing device comprises an image analytics module capable of determining whether a specific parking slot/lane is occupied or empty. The built-in image analysis module of the image-capturing device compares the image of an empty slot and the captured images, and
30 confirms the parking space occupied if at least a few of the stream of captured images show the parking space occupied. Similarly, for an occupied parking

space, the built-in software of the image analysis module compares the image of the occupied lot/lane and the captured images, and confirms the parking space has become empty after the vehicle has moved out if a few captured images show the parking space empty.

- 5 In some embodiments, the image analysis module of the image-capturing device analyses the captured images to generate an identifier of the vehicle (e.g., vehicle plate number, vehicle IU number, vehicle colour, vehicle logo, vehicle model) (i.e., “the first identifier”), stores the identifier as electronic data (e.g., text) and transmits the first identifier to a validation module 106. In some
10 embodiments, the image analysis module utilizes an Optical Character Recognition (also known as optical character reader, OCR) software or algorithm to convert possible texts (e.g., vehicle plate number) on the captured images into machine-encoded text.

Figure 2 shows an example of the captured image 200 and the vehicle plate
15 numbers that can be extracted from the captured image. As shown in Figure 2, the capture image 200 comprises three vehicles (202, 204 and 206) parking at three parking spaces. Their corresponding vehicle plate numbers (SJA2345B, SJJ1234A and SDV3456C) can be extracted from the captured image 200 using, for example, OCR software. Thus, in the specific
20 embodiment of Figure 2, one detection sensor 102 (e.g., image-capturing device) is able to monitor and manage three parking spaces.

Figure 3 illustrates another embodiment of the present invention that has an imaging capturing device 102 capable of monitoring vehicles parking on opposite sides of a driving lane (e.g., 112a and 112b).

- 25 In some embodiments, the image analysis module comprises a vehicle logo recognition module operable to recognize the logos on the captured images as a possible identifier or identification information. The term “vehicle logo” refers to a symbol, an emblem, a badge or an image design adopted by a vehicle manufacturer to identify its vehicles products (e.g., the 4-ring logo of
30 Audi; the H logo of HondaTM; the three-pointed star of Mercedes-BenzTM). The

vehicle logo recognition module may utilize content-based image retrieval (CBIR) algorithms (e.g., reverse image search) to facilitate logo recognition.

In some embodiments, the image analysis module comprises a colour recognition algorithm operable to recognize the colour of the vehicle based on
5 the captured images.

In some embodiments, the detection sensor 102, in addition to extracting identifiers of parking vehicles, is also operable to generate and/or store other types of information related to the vehicle parking, such as the date of parking, the time of parking, the parking space number as well as the name of the
10 vehicle park). For example, the detection sensor 102 may be equipped with a digital clock that is in synchronization (e.g., via internet connection or manual setting) with local time (i.e., the standard time used in the place where the vehicle park is located). Thus, the date and time of vehicle parking can be captured. The detection sensor 102 can be tagged with the name and other
15 details of the vehicle park (e.g., name, location, and management company of the vehicle park) so that information as to the vehicle park can be obtained. Parking spaces monitored by the detection sensor 102 can also be labelled with a particular serial number so that the parking location of the parking vehicle can also be captured.

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Base Station 104

After the detection sensor 102 detects the presence of the vehicle 112 at the location 110, a base station 104 of the vehicle parking management system 100 can be activated to communicate with a vehicle communication device
25 114 of the vehicle 112. The base station 104 is a communication device installed in vicinity of the location 110. Examples of the communication protocols utilized by the base station 104 and the vehicle communication device 114 include, but not limited to, BLUETOOTH™, WiFi, ZigBee and 2G/3G/4G cellular.

In some embodiments, the vehicle communication device 114 of the vehicle 112 is a vehicle IU that is equipped with a plurality of communication means communicating via communication protocols such as, the Global Positioning System (GPS), 2G/3G/4G cellular and BLUETOOTH™. The vehicle IU may
5 comprise a unique identification number (i.e., IU number) linked to the details of the vehicle 112 (e.g., vehicle plate number, model and colour) and the particulars of the registered vehicle driver (e.g., name, gender and driving license number).

If a communication is successfully established between the base station 104
10 and the vehicle communication device 114, the vehicle communication device 114 (e.g., the IU) can transmit identifiers of the vehicle 112 and/or the vehicle driver as stored in the vehicle communication device 114 to the base station 104. Thus, the communication between the base station 104 and the vehicle communication device 114 serves at least two purposes. First of all, the
15 successful establishment of communication between the base station 104 and the vehicle communication device 114 indicates that the vehicle 112 is located in close proximity to the base station 104, confirming the detection result of the detection sensor 102 (e.g., the vehicle 112 is present at the location 110). Secondly, the identifier transmitted from the vehicle communication device
20 114 to the base station 104 (i.e., “second identifier”) could be utilized to compare with the identifier obtained from the detection sensor 102 (e.g., vehicle plate number, vehicle model, vehicle colour identified by the detection sensor) (i.e., “the first identifier”). If the first identifier and the second identifier are consistent (e.g., the vehicle plate number identified by the detection
25 sensor 102 is the same as the vehicle plate number obtained by the base station 104), the vehicle parking management system 100 confirms that details of the vehicle 112 (and the vehicle driver) are accurate. If there is any discrepancy detected (e.g., the vehicle plate numbers identified by detection sensor 102 and the base station 104 differ at, for example, one or more
30 alphabets, numbers or symbols), the vehicle parking management system 100 might activate the detection sensor 102 and/or the base station 104 to retrieve identifiers of the vehicle 112 again for further comparison. The vehicle parking

management system 100 may also send an alert signal to alert a vehicle park manager 126 to inspect the vehicle 112 on site.

In some embodiments, the base station 104, in addition to retrieving vehicle identification information/data from the vehicle communication device 114, is also operable to generate and/or store information related to vehicle parking such as the date of parking, the time of parking, an identifier of the parking space (e.g. serial number) as well as the name of the vehicle park. For example, the base station 104 may be equipped with a digital clock that is in synchronization (e.g., via internet connection or manual setting) with local time (i.e., the standard time used in the place where the vehicle park is located). Thus, the date and time of vehicle parking can be captured. The base station 104 can be tagged with the name and other details of the vehicle park (e.g., name, location, and management company of the vehicle park) so that information as to the vehicle park can be obtained. Parking spaces monitored by the base station 104 can also be labelled with a particular serial number so that the parking location of the parking vehicle can also be captured.

Validation Module 106

The comparison between the first identifier and the second identifier can be facilitated by a validation module 106. In some embodiments, the validation module 106 is a processor capable of receiving the first identifier and the second identifier, and comparing the two identifiers to detect any discrepancy and/or inconsistency.

In some embodiments, each identifier includes only one identification information/data. In some embodiments, each identifier includes a plurality of identification information/data. However, it is also possible that there is no identification information/data in an identifier if no identification information/data can be retrieved from the detection means due to various reason(s). For example, if a vehicle's license plate is covered with dirt or mud or image-blocking articles, the image analysis module of the image-capturing device may not be able to generate any information/data as to the vehicle

plate number. Thus, the identifier will carry no identification information/data (i.e., an “invalid identifier”). If either the first identifier or the second identifier is an invalid identifier, the validation module 106 determines that there is inconsistency (or discrepancy) detected. In other words, even when both the
5 first identifier and the second identifier appear to be similar invalid identifiers, the validation module 106 determines that there is inconsistency (or discrepancy) detected.

In some embodiments, each identification information/data of an identifier is tagged or categorized according to its nature and type. The validation module
10 106 is operable to compare each and every identification information/data of the same category or type across the first identifier and the second identifier. For example, the vehicle plate number obtained from the detection sensor 102 is compared against the corresponding vehicle plate number retrieved by the base station 104 from the vehicle communication device 114; the vehicle
15 model obtained from the detection sensor 102 (e.g., via a vehicle logo recognition module) is compared against the corresponding vehicle model information retrieved by the base station 104 from the vehicle communication device 114.

After comparing each and every identification information/data, the validation
20 module 106 will then be able to determine whether the first identifier is consistent with the second identifier (i.e., no discrepancy between the two identifiers). The criteria for the two identifiers to be considered “consistent” (i.e., “no discrepancy”) can be configured by the manager/administer 126 of the vehicle park. In some embodiments that require stringent identification of
25 vehicles, being “consistent” requires each and every type of identification information/data to be identical across the two identifiers. In some embodiments, for the identifiers to be “consistent” (i.e., no discrepancy), only some key types of identification information/data (e.g., vehicle plate number, driver license number) are required to be identical, while differences between
30 less important types of identification information/data such as vehicle colour are disregarded.

In some embodiments, there comprises a predetermined threshold such that when the degree of similarity between the first identifier and the second identifier are more than the predetermined threshold, the two identifiers are considered to be consistent. In other embodiments, the degree of dissimilarity
5 between the first identifier and the second identifier are more than the predetermined threshold, the two identifiers are considered not to be consistent.

In some embodiments, if any discrepancy or inconsistency is detected, the validation module 106 is configured to rely more on the second identifier
10 obtained via the base station 104, adopting the second identifier and disregarding the differences in the first identifier. In some embodiments, if any discrepancy or inconsistency is detected, the validation module 106 is configured to rely more on the first identifier obtained via the detection sensor 102, adopting the first identifier and disregarding the differences in the second
15 identifier.

In some embodiments, if a discrepancy or inconsistency is detected, the validation module 106 will first attempt to resolve the discrepancy automatically by activating the detection sensor 102 and/or the base station 104 to retrieve the identification information/data again for further comparison.
20 However, this approach, if after being repeated a predetermined number of times (e.g., 3 times), is still unable to resolve the discrepancy, the validation module 106 is then configured to send an alert message to a vehicle park manager 126. In some embodiments, the validation module 106 can be configured to send an alert message to the vehicle communication device 114
25 (e.g., IU) and/or the driver of the vehicle 112 as well (e.g., smart phone of the driver). The alert message sent by the validation module 106 to the vehicle park manager 126, the driver of the vehicle 112, and/or the vehicle communication device 114 can be in any electronic format. In some specific embodiments of the invention, the alert message is a Short Message Service
30 (SMS), Multimedia Message Service (MMS), iMessage, IP-based message or any other types of electronic message.

In some embodiments, in addition to the detection sensor 102 and the base station 104, there are other apparatuses or devices (e.g., loop sensor, infrared sensor) that can function to detect the presence of vehicle and retrieve identification information/data of the vehicle 112. The validation module 106
5 can then be configured to compare across multiple identifiers to detect discrepancy and maximizes accurate identification of vehicles. Thus, the vehicle parking management system 100 of the present invention is able to accommodate two or more types of detection/identification means, and to facilitate comparing two or more identifiers from different
10 detection/identification means.

Parking Timer 120

In some embodiments, the vehicle parking management system 100 further comprises a parking timer 120 that is configured to start timing the parking
15 period (also known as “parking interval”; “parking duration”) once the validation module 106 determines that there is no discrepancy between the first identifier and the second identifier. In some embodiments, the parking timer 120 is configured to stop timing the parking period, once the detection sensor 102 and/or the base station 104 finds the vehicle 112 leaving the
20 parking space 110. For example, in some embodiments, the base station 104 is configured to repeatedly communicate with the vehicle communication device 114 at every predetermined time interval (e.g., at every 30 seconds). The parking timer 120 is configured to stop timing the parking period once the base station 104 fails to communicate with the vehicle communication device
25 114.

In some embodiments, the detection sensor 102 is an image-capturing device configured to capture an image of the parking vehicle 112 at every predetermined time interval (e.g., at every 30 seconds), and to obtain the vehicle plate number of the parking vehicle 112 from the captured image by
30 applying, for example OCR means. The parking timer 120 is configured to

stop timing the parking period once the image-capturing device can no longer capture any image of the parking vehicle 112.

In some embodiments, the image-capturing device 102 detects the vehicle out of a parking slot/lane by comparing a stream of images captured in sequence,
5 and stops the parking timer 120 accordingly.

In some embodiments, the image-capturing device 102 comprises an image analytics module capable of determining whether a specific parking space/lane is occupied or empty. For example, the built-in image analysis module of the image-capturing device 102 compares the image of an empty
10 slot 110 and the captured images, and confirms the parking space 110 has become empty after the vehicle 112 has moved out if a predetermined number of captured images (e.g. 15-20 frames) show the parking space 110 empty. The parking timer 120 is configured to stop once the built-in image analysis module confirms that the parking space 110 is empty.

15 In some embodiments, the parking timer 120 is a digital timer capable of converting the starting and ending time of the parking period into digital data and communicating them to other components of the vehicle parking management system 100 (e.g., a toll calculator 122) and the vehicle communication devices 114 (e.g., vehicle IU). In some embodiments, the
20 parking timer 120 functions as a stopwatch, counting upwards from zero for measuring elapsed time.

In some embodiments, the parking timer 120 is integrated with the vehicle communication device 114. In some embodiments, the validation module 106 is configured to communicate with the parking timer 120 via the base station
25 104 (i.e., the parking timer 120 starts timing the parking period after the validation module 106 indicates "consistency" or "no discrepancy", via the base station 104, to the parking timer 120 integrated into the vehicle communication device 114).

Toll Calculator 122

In some embodiments, the parking timer 120 is arranged to be in data communication with a toll calculator 122. The toll calculator 122 is operable to
5 calculate the parking fee for a particular vehicle 112 based on the time period generated by the parking timer 120, as well as the corresponding parking fee scheme for the specific time period and/or the specific parking space. In some embodiments, the toll calculator 122 comprises a processor operable to receive information (e.g., updates, revisions) on the parking fee scheme that
10 specifies the applicable fees for specific lots and time periods (e.g., high parking fee for a convenient parking space during peak hour). In some embodiments, the parking fee scheme applies discount rates for certain vehicles (e.g., vehicles that frequent the vehicle park).

In some embodiments, the toll calculator 122 can be integrated with the
15 validation module 106, the base station 104 and/or the detection sensor 102. In some embodiments, the toll calculator 122 and the parking timer 120 are both integrated with the vehicle communication device 114 (e.g., vehicle IU). In some embodiments, the toll calculator 122 is integrated with the server 108.

Toll Payment Terminal 124

In some embodiments, the toll calculator 122 is arranged to be in data communication with a toll payment terminal 124. The toll payment terminal is a hardware device or a software module that interfaces with payment cards (e.g., stored-value card, debit card, credit card, cashcard) or bank accounts of
25 the vehicle drivers to facilitate electronic funds from the vehicle drivers to the vehicle park owners. The toll payment terminal is in general able to transmit data to, for example, the relevant banks, for their authorization/authentication and processing of the payment. The data transmission can be via standard telephone line, a wired or wireless internet connection, cellular or satellite
30 networks.

In some embodiments of invention, upon receiving the parking fee payable (also known as toll) from the toll calculator 122, the toll payment terminal 124 then facilitates deducting the corresponding parking fee amount from the driver's payment cards or bank account linked to the toll payment terminal 124.

In some embodiments, the toll payment terminal is integrated into the vehicle IU so that the vehicle IU can function to facilitate the payment – a payment card (e.g., stored value card, debit card, credit card) is inserted into the IU, and the parking fee payable is deducted from the payment card. In some embodiments, no payment card is required. The IU is directly associated with a payment account of the vehicle driver. The payment account may be a bank account or an electronic wallet account. In some embodiments, the IU and the payment terminal are two separate apparatuses arranged to be in data communication (e.g., via wireless connection). In some embodiments, the toll payment terminal 124 is a mobile app installed in a smart phone, and is capable of communicating with the IU 114 via a wireless network. In some embodiments, both the toll payment terminal 124 and the IU 114 are integrated into a mobile phone.

20 Server 108

In some embodiments, the vehicle parking management system 100 further comprises a server 108. The server 108 comprises a database for storing information and data generated by various components of the vehicle parking management system 100, such as captured images (if the detection sensor 102 is an image-capturing device), the first identifier from the detection sensor 102, the second identifier from the base station 104, the results of the comparison at the validation module 106 (e.g., discrepancy detected), the details of the alert messages generated by the validation module 106, the parking period/duration from the parking timer 120, the parking fee payable

generated by the toll calculator 122, and the payment records at the toll payment terminal 124.

In some embodiments, the database is configured to build up profiles of vehicles that have parked at the vehicle park, such as consolidating validated
5 identification information/data of a vehicle into a single file. When the same vehicle comes to park at the vehicle park again, the server can use the identification information/data obtained from either the detection sensor 102 or the base station 104 to retrieve more identification information/data of the vehicle from the database.

10 For example, assume vehicle "V" parked at a vehicle park "VP" before, identifier of the vehicle "V" (comprising various identification information/data of the vehicle "V") was captured and stored at a database of a backend server of the vehicle park "VP". Thus, when the vehicle "V" enters and parks at the vehicle park "VP" again, once the detection sensor 102 utilizes OCR algorithm
15 to obtain the vehicle plate number from the captured images of "V", the detection sensor 102 is operable to communicate the obtained vehicle plate number to the backend server of the vehicle park "VP" to retrieve more identification information/data (e.g., vehicle V owner's name and driving license number, vehicle V's model, vehicle V's colour) about the vehicle V
20 from the database of the backend server.

The profiles of vehicles can also be shared (e.g., via internet) among the vehicle parking management systems of multiple vehicle parks, facilitating vehicle identification and recognition in different vehicle parks.

In some embodiments, the payment-related components (e.g., toll-calculator
25 122, toll payment terminal 124) of the vehicle parking management system 100 are managed by a cloud-based data management system. The cloud-based data management system can be further integrated with other databases such as a database of drivers' accounts ("account database") – for example, a residential vehicle park may require all its regular/long-term users
30 to register an electronic account with its account database by submitting

information such as the particulars of the driver, the details of his/her vehicle, and the bank account information of the drivers (e.g., credit card account; online banking account; PayPalTM, EZPAYTM). One or more of the
5 aforementioned information may be used to generate one or more user profiles. Once the cloud-based data management system determines the parking fees payable, it is operable to communicate the information to the account database, which then operates to deduct the parking fees from the
10 corresponding account of the driver. In some embodiments, in order to cater to ad-hoc parking, the payment-related components (e.g., toll-calculator 122, toll payment terminal 124) can be installed at the vehicle parks as an interactive kiosk for manual payment by drivers. Drivers, who have neither an existing account associated with the vehicle park management nor any payment card integrated with the vehicle IU, can make payment at the interactive kiosk.

15 In some embodiments, instead of installing a physical kiosk, the payment-related components (e.g., toll-calculator 122, toll payment terminal 124) can be associated with mobile payment schemes such as DBS PaynowTM, WeChatTM, and QR code-based payment systems.

Figure 1 illustrates one specific embodiment of the vehicle parking
20 management system 100 that has the detection sensor 102, the base station 104, the validation module 106, the parking timer 120 and the toll calculator 122 to be arranged in data communication. Specifically, both the detection sensor 102 and the base station 104 are linked to the validation module 106, and the validation module 106 is linked to the parking timer 120, the toll
25 calculator 122, and the server 108. The validation module can also communicate alert messages (reporting discrepancy between the identifiers obtained from different detection means) to a vehicle park manager. The components of the vehicle parking management system 100 can also be configured in other manners. For example, the parking timer 120, the toll
30 calculator 122 and the validation module 106 can be integrated into a single

apparatus capable of performing multiple functionalities; the detection sensor 102 and the base station 104 can be integrated into a single apparatus.

The different components of the vehicle parking management system 100 may communicate with each other via wired or wireless data communication channel utilizing well-established data communication protocol, such as Transmission Control Protocol/Internet Protocol (TCP/IP). In some embodiments of the invention, the communication channel may be a power-line communication (PLC) (also known as power-line carrier, power-line digital subscriber line (PDSL), power-line telecommunications, power-line networking), a communication protocol that uses electrical wiring to simultaneously carry both data, and Alternating Current (AC) electric power transmission or electric power distribution.

The communication between the vehicle communication device 114 and other components of the vehicle parking management system 100 can also be via wired or wireless data communication channel utilizing well-established data communication protocol, such as Transmission Control Protocol/Internet Protocol (TCP/IP).

Method

As illustrated in Figures 4 and 5, in accordance with another aspect of the invention there is a method for managing a vehicle park, comprising the steps of:

- (Step (a)) detecting a presence of a vehicle 112 at a location (e.g., parking space) 110 and obtaining a first identifier of the vehicle 112 by a detection sensor 102 (step 402),
- (Step (b)) activating a base station 104 by the detection sensor 102 to communicate with a vehicle communication device 114 of the vehicle 112 to receive a second identifier of the vehicle 112 (step 404), and

- (Step (c)) comparing the first identifier and the second identifier by a validation module 106 to determine whether there is any discrepancy between the first identifier and the second identifier (step 406) as described in earlier embodiments. In some embodiments, the validation module 106 is operable to compare each and every identification information/data under the same category and type for detecting discrepancy. For example, the vehicle plate number obtained from the detection sensor 102 is compared against the corresponding vehicle plate number retrieved by the base station 104 from the vehicle communication device 114; the vehicle model obtained from the detection sensor 102 (e.g., via a vehicle logo recognition module) is compared against the corresponding vehicle model information retrieved by the base station 104 from the vehicle communication device 114.
- After comparing each and every identification information/data, the validation module 106 will then be able to determine whether the first identifier is consistent with the second set of identification (i.e., no discrepancy between the two identifiers). The criteria for the two identifiers to be considered "consistent" can be set/adjusted by the manager/administer 126 of the vehicle park. In some embodiments, being "consistent" (i.e., no discrepancy) strictly requires each and every type of identification information/data to be identical across the two identifies. In some embodiments, being "consistent" (i.e., no discrepancy) only requires some key types of identification information/data (e.g., vehicle plate number, driver license number) to be identical across the two identifiers, while differences between less important types of identification information/data such as vehicle colour are disregarded.

If the validation module 106 reports no discrepancy between the first identifier and the second identifier, the method of the present invention then activates a parking timer 120 to start timing the parking duration (step (d) or step 414).

- If, however, the validation module 106 finds one or more discrepancies (e.g., the vehicle plate numbers identified by the detection sensor 102 and the base

station 104 are different), the method of the present invention then repeats the earlier steps (i.e., 402, 404 and 406) (step (e)) for a predetermined number of times (e.g., 3 times). In some embodiments, before repeating the step 406, the method only repeats the step 402 to instruct the detection sensor 102
5 (e.g., an image-capturing device) to recapture an image of the vehicle 112 and to extract the vehicle plate number using the recaptured image (step 410a). In some embodiments, before repeating the step 406, the method only repeats the step 404 to command the base station 104 to communicate with the vehicle communication device 114 again to extract the second identifier
10 stored in the vehicle communication device (step 410b).

In some embodiments, the validation module 106, upon detecting discrepancy between the first identifier and the second identifier, transmits an alert message to a vehicle park manager 126 (step (f) or step 412). The vehicle park manager 126 can then proceed to the specific parking space 110 to
15 inspect the parking vehicle 112. In some embodiments, the validation module 106 is configured to transmit an alert message to a vehicle park manager 126 only if repeating step 402 and/or step 404 for a predetermined number of times still fails to resolve the discrepancy.

After the parking timer 120 starts timing the parking period, the base station
20 104 is configured to repeatedly communicate with the vehicle communication device 114 at every predetermined time interval (e.g., 30 seconds, 1 min) (step (g) or step 416). The purpose of the step 416 is to check whether the vehicle 112 is still present at the parking space 110. If a communication between the base station 104 and the vehicle communication device 114 is
25 successful, the method of the present invention then returns to the step 416 to activate the base station 104 to repeatedly communicate with the vehicle communication device 114 at every predetermined time interval (e.g., 30 seconds, 1 min).

However, if the base station 104 fails to communicate with the vehicle
30 communication device 114, the method of the present invention then proceeds to stop the parking timer 120 (step (h)), and a parking time period

(also known as parking period, parking duration) can be then computed (step (l) or step 420). Thereafter, the parking time period is transmitted to a toll calculator 122 operable to calculate the parking fee payable based on the parking time period from the parking timer 120 and the applicable fee scheme for the specific parking space 110 at the specific time (step (m) or step 422). Information as to the parking fee payable is then transmitted to a toll payment terminal 122 operable to deduct the corresponding amount from the linked account (e.g., credit card account, debit card account, cashcard) (step (n) or step 424).

10

As illustrated in Figure 5, in some embodiments, when the base station 104 fails to communicate with the vehicle communication device 114, the detection sensor 104 is activated to assess whether the vehicle 112 is still at the parking space 110 (step (i) or step 426). In some embodiments wherein the detection sensor 104 is an imaging capture device, the detection sensor 104 is capable of capturing images of the specific parking space to determine whether the parking space is empty or occupied, or capturing images of the parking vehicle 112 to determine whether it is the same vehicle parking (or a different one) at the parking space 110.

20

If the detection sensor 10 indicates that the same vehicle 112 is still at the parking space 110, the base station 104 is then activated to communicate with the vehicle communication device 114 again to check whether the vehicle 112 is still in vicinity of the base station 104 (step 428a).

25

- If the base station 104 manages to establish communication with the vehicle communication device 114 this time, then the base station 104 is arranged to repeatedly communicate with the vehicle communication device 114 at every predetermined time interval to continuously monitor the status of the parking vehicle 112 (e.g., present or absent) (step 418a).

30

- However, if the base station 104 still fails to communicate with the vehicle communication device 114, then an alert message is

transmitted to a vehicle park manager 126 on the discrepancy between the detection results of the detection sensor 102 (e.g., the images of the vehicle 112 can be captured and recognized) and the base station 104 (e.g., the base station 104 cannot communicate with the vehicle communication device 114) (step (k) or step 430). The vehicle park manager 126 can then proceed to inspect the parking space 110.

After the steps 418 and 426, if the detection sensor also fails to locate the parking vehicle 112, it is then confirmed that the vehicle 112 has left the parking space. Accordingly, the parking timer 120 is stopped (step (j)), and a parking time duration (also known as parking period, parking duration) is computed (step (l) or step 420). Thereafter, the parking time period is transmitted to a toll calculator 122 operable to calculate the parking fee payable based on the parking time period from the parking timer 120 and the applicable fee scheme for the specific parking space at the specific time (step (m) or step 422). Information as to the parking fee payable is then transmitted to a toll payment terminal 122 operable to deduct the corresponding amount from the linked account (e.g., credit card account, debit card account, cashcard) (step (n) or step 424).

In some embodiments, the detection sensor 102 is an image-capturing device (e.g., surveillance cameras ubiquitously installed across the vehicle park); the base station 104 is a BLUETOOTH™ device capable of communicating with another BLUETOOTH™ device over a distance within about 10 meters or 30 fts; and the vehicle communication device 114 is a vehicle IU having BLUETOOTH™ functionality.

The present invention offers several technical advantages over vehicle parking management systems that rely on a single type of detection mode.

For example, if only an imaging capturing device is utilized to detect the presence of vehicle, the identification information/data of the vehicle (e.g., vehicle plate number, vehicle model, vehicle colour) might be obtained

wrongly due to various reasons such as lighting environment (e.g., too dark), unrecognizable plate number (e.g., due to dirt, muds, scratches, view-blocking articles that obscure the vehicle plate numbers), errors in the image analysis module (e.g., OCR) of the image-capturing device. Any mistake in identifying the vehicle information might cause problems in collecting parking fee, and even result in disputes between, for example, the vehicle owners and the vehicle park management.

Similarly, only utilizing a base station such as BLUETOOTH™ device to detect and identify parking vehicles is also problematic as the BLUETOOTH™ device cannot differentiate vehicles by their specific parking spaces within its detection range (e.g., 10 meters). In other words, if a BLUETOOTH™ device detects the IU of a vehicle, it only indicates that the vehicle is parking within the detection range of the BLUETOOTH™ device. It is difficult to identify the specific parking space of the parking vehicle. Accordingly, it is challenging to implement fine-tuned parking schemes (e.g., based on specific parking spaces: e.g., high toll for convenient parking space; low toll for inconvenient parking space) to facilitate efficient use of the vehicle parking space, as well as to increase the revenue for the vehicle park owner.

Also, if either the base station 104 or the vehicle communication device 114 breaks down (or is tampered) so that no communication can be established the two communication devices, the parking vehicle 112 might therefore go undetected, resulting in loss of parking fee revenue for the vehicle park owner.

Having both an image-capturing device 102, a BLUETOOTH™ device 104 and a validation module 106 can effectively alleviate at least some of the technical problems identified above.

First of all, having two (or more) vehicle detection and identification methods (e.g., 102, 104) and a validation module 106 maximizes accurate vehicle detection and identification. Discrepancy or inconsistency between the identifiers retrieved from different detection and identification methods will alert the vehicle park manager 126 to inspect the parking space 110 and the

parking vehicle 112, hence avoiding loss of revenue due to parking fee evasion activities and/or system errors.

For example, as illustrated in Figure 6, the license plate of the vehicle in the middle (i.e., the car parking at the lot 4168) has been damaged, probably due to scratches. Therefore, it is difficult for the image-capturing device to determine the exact vehicle plate number based on the captured image 602 (for example, the image-capturing device is only able to generate a partial vehicle plate number SKC25?9D (604)). The base station 104 however is able to detect that the vehicle plate number to be SKC2539D (606), via communicating with the vehicle IU 114 that stores identification information/data of the vehicle 112 and/or the driver. The validation module 106, based on the results from both the image-capturing device and the base station 104, accordingly confirms that the vehicle plate number is SKC2539D.

In another example, the image-capturing device, based on the captured image, identifies the vehicle plate number to be SDV3456C. This vehicle plate number however is wrong because (i) the final character ("O") of the vehicle plate number is partially covered by mud, and appears as "C" instead; the second character ("O") of the vehicle plate number appears similar to "D". The base station 104 is able to obtain the correct vehicle plate number "SOV3456O" via communicating with the vehicle IU 114 that stores identification information/data of the vehicle 112 and/or the driver. The validation module 106 compares the two vehicle plate numbers obtained, and identifies two discrepancies. In some embodiments, the validation module 106 then transmits an alert message to request a vehicle park manager 126 to inspect the parking vehicle 112 and the parking space 110. In some embodiments, the validation module 106 is configured to rely more on the identifier obtained via the vehicle IU 114, and to disregard certain minor discrepancies. For example, if the difference is between the characters "O" (from the vehicle IU) and "D" (OCR from the captured image), the validation module 106 is configured to straightaway adopt "O" as the correct character

without the need to repeat detections for confirmation or send any alert message.

Secondly, the image-capturing device 102 is able to identify the exact parking spaces of parking vehicles, as the image-capturing device 102 is in general
5 installed at a fixed location, and can therefore correspond vehicles on the captured images to specific parking spaces (Figure 2). The base station 104, such as a BLUETOOTH™ device, can function to retrieve accurate identification information/data of the parking vehicle from the vehicle IU. Thus, the vehicle parking management system 100 of the present invention, having
10 both the imaging capturing device and the BLUETOOTH™ device, is able to obtain accurate identifier of a parking vehicle at a particular parking space. The present invention therefore can enable the vehicle park management to implement fine-tuned parking fee scheme based on the convenience of parking spaces.

15 In fact, the present invention is particularly useful for vehicle parks that have small and crowded parking spaces, such as vehicle parks that implement multilevel stack vehicle parking system 700 that allows two or more vehicles (112a, 112b, 112c) to be stacked one above the other at the same parking space (Figure 7). As the detection sensor 102 (e.g., image-capturing device)
20 can indicate exactly which level a particular parking vehicle parks at, and the base station 104 (e.g., a BLUETOOTH™ device) can retrieve accurate identifier of the parking vehicle from the vehicle IUs, it is possible for the park management to implement different parking fees for different levels (e.g., lower tolls for the higher levels and higher tolls for the lower levels),
25 accordingly facilitating efficient use of the vehicle parks.

For vehicle parks that have already installed surveillance cameras, implementing the present invention requires little change and/or addition in the existing hardware infrastructure. Thus, in comparison to other new vehicle park management systems, the present invention is cost-effective to
30 implement, operate and maintain.

As the activities at every parking lot are being monitored, recorded and managed, every parking lot, to some extent, functions like a mini-car park. With the technical advantages indicated above, the present invention enables vehicle parks to be gantry-free/gantry-less, easing traffic flow in the vehicle parks and improving efficiency and reliability in payment collection.

The above is a description of embodiment(s) of an apparatus, system and method for managing vehicle parking. It is to be further appreciated that technical features from one or more embodiments as described may be permutated and/or combined to form further embodiments without departing from the scope of the present invention.

CLAIMS

1. A vehicle parking management system comprising:
a detection sensor operable to detect a presence of a vehicle at a location,
5 and to obtain a first identifier of the vehicle,
a base station operable to communicate with a vehicle communication
device of the vehicle to receive a second identifier of the vehicle after the
detection sensor detects the presence of the vehicle at the location,
a validation module configured to receive the first identifier and the second
10 identifier,
wherein the validation module is operable to compare the first identifier
with the second identifier to determine whether there is any discrepancy
between the first identifier and the second identifier,
wherein the vehicle parking management system further comprises a
15 parking timer configured to start timing once the validation module
determines that there is no discrepancy between the first identifier and the
second identifier; and
wherein the base station is configured to repeatedly communicate with
the vehicle communication device at every predetermined time interval,
20 and the parking timer is configured to stop timing once the base station
fails to communicate with the vehicle communication device.
2. The vehicle parking management system of claim 1, wherein detection
sensor is an image-capturing device.
25
3. The vehicle parking management system of claim 1 or claim 2, wherein
the base station and the vehicle communication device comprises one or
more of the following: BLUETOOTH™, WiFi, ZigBee and 2G/3G/4G cellular.
- 30 4. The vehicle parking management system of any preceding claim, wherein
the first identifier comprises vehicle plate number of the vehicle, vehicle
color, vehicle model, or any combination thereof.

5. The vehicle parking management system of claim 4, wherein the second identifier comprises vehicle plate number of the vehicle, vehicle color, vehicle model, vehicle IU number, vehicle owner name, or any combination thereof.

5

6. The vehicle parking management system of any preceding claim, further comprising a toll calculator arranged to be in data communication with the parking timer.

10

7. The vehicle parking management system of any preceding claim, wherein the vehicle communication device is arranged to be in data communication with a toll payment terminal.

15

8. The vehicle parking management system of any preceding claim, wherein the validation module is operable to send an alert message to a vehicle park manager, the vehicle communication device, an owner of the vehicle or any combination thereof.

20

9. The vehicle parking management system of any preceding claim, further comprising a database configured to store the first identifier and the second identifier.

25

10. A method for managing a vehicle park, comprising steps of:
- (a) detecting a presence of a vehicle at a location and obtaining a first identifier of the vehicle by a detection sensor,
 - (b) activating a base station by the detection sensor to communicate with a vehicle communication device of the vehicle to receive a second identifier of the vehicle,
 - (c) comparing the first identifier and the second identifier by a validation module to determine whether there is any discrepancy between the first identifier and the second identifier,

30

- (d) activating a parking timer to start timing, if there is no discrepancy detected in the step (c).
- (g) repeatedly activating the base station to communicate with the vehicle communication device at every predetermined time interval, and
- 5 (h) stopping the parking timer, if the base station fails to communicate with the vehicle communication device in the step (g).
11. The method of claim 10, further comprising a step (e) of repeating the step (a), the step (b) and the step (c), if there is at least one discrepancy
- 10 detected in the step (c).
12. The method of claim 11, further comprising a step (f) of transmitting a first alert message by the validation module to a vehicle park manager, if the step (e) has been repeated a predetermined number of times.
- 15 13. The method of claim 10, 11 or 12, further comprising a step (i) of detecting the presence of the vehicle by the detection sensor, if the base station fails to communicate with the vehicle communication device in the step (g).
- 20 14. The method of claim 13, further comprising a step (j) of stopping the parking timer, if the detection sensor fails to detect the presence of the vehicle at the step (i).
- 25 15. The method of claim 13, further comprising a step (k) of transmitting a second alert message to the vehicle park manager, if the detection sensor detects the presence of the vehicle at the step (i).
16. The method of claim 10 or 14, further comprising a step (l) of calculating a parking time duration by the parking timer.
- 30 17. The method of claim 16, further comprising a step (m) of calculating a toll for the vehicle based on the parking time duration by a toll calculator.

18. The method of claim 17, further comprising a step (n) of making payment for the toll at a toll payment terminal.