INTELLIGENT CAR PARK SYSTEM

FIELD OF THE INVENTION

The present invention relates to a computer-based intelligent car park system and method for automatically controlling vehicle exit from a car park.

BACKGROUND TO THE INVENTION

Many car park operators still currently employ personnel to man the entry and/or exit booths of car parks in order to supervise the orderly entry and exit of vehicles. Such car park attendant personnel are also responsible for collecting payment and/or applying the applicable charges to car park user's accounts. In view of the relatively high labour cost of paying car park attendants, other car park operators have opted for fully or semi-automated systems in which the car park can be left unattended. For example, in one such prior art fully automated system, the vehicle driver takes an entry card from a dispenser at the entry point to the car park which opens a boom gate to allow entry to the car park. Upon returning to the car park, the driver inserts the entry card in a vending machine which calculates the applicable charge and authorises the card for exit upon payment of the required amount into the vending machine. The same entry card is inserted into a card reader at the point of exit, which will automatically open the exit boom gate if the card has been authorised for exit. An obvious disadvantage of this prior art system is the inconvenience involved in the driver having to first find the vending machine and then provide correct payment in order to exit the car park.

A further disadvantage of this and similar prior art automated car park systems is that they cannot readily distinguish between a variety of types of motor vehicles for which different charging rates may be applicable.

SUMMARY OF THE INVENTION

The present invention was developed with a view to providing an intelligent car park system which overcomes at least some of the problems with prior art systems noted above, and which is convenient to use by drivers of vehicles using the car park.

According to one aspect of the present invention there is provided a method of automatically controlling vehicle exit from a car park using a computer-based intelligent car park system, the method comprising the steps of:

detecting the presence of a vehicle about to enter or exit the car park;

capturing one or more images of the vehicle including its licence plate;

processing the image or images of the vehicle including its licence plate in order to recognise identifying features on the vehicle and licence plate to thereby obtain identifying information which identifies the vehicle; and,

at the time of entry of the vehicle to the car park, recording said identifying information together with time of entry of the vehicle; or, at the time of exit of the vehicle:

matching said identifying information with information previously recorded in the database; and,

allowing exit of the vehicle from the car park.

Preferably the method further comprises the step of allowing or disallowing entry of the vehicle into the car park.

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Preferably the method further comprises the steps of:

calculating applicable charges for the period of time the vehicle has been parked in the car park; and,

processing payment of the applicable charges or capturing credit information for future payment of such charges.

Advantageously the method further comprises the step of comparing said identifying information with information stored in a knowledge base in order to identify whether the vehicle falls into a particular category of motor vehicle and to otherwise differentiate vehicles. For example, the knowledge base may include information for identifying a taxi, goods vehicle, lorry and an ordinary domestic passenger vehicle, for which different car park charging rates are applicable. Also by being able to differentiate vehicles compliance with security and safety requirements can be ensured, for example, ensuring a vehicle does not exceed height limits.

Typically, the method also includes the step of comparing said identifying information with information stored in a database in order to identify whether the vehicle has a season pass for using the car park, wherein the applicable charges are levied on a weekly, monthly, quarterly or other seasonal basis. Preferably said step of processing payment includes automatically debiting if appropriate the user's account if the vehicle has a season pass.

According to another aspect of the present invention there is provided a computer-based intelligent car park system for automatically controlling vehicle exit from a car park, the system comprising:

means for detecting the presence of a vehicle about to enter or exit the car park;

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means for capturing one or more images of the vehicle including its licence plate;

means for processing the image or images of the vehicle including its licence plate in order to recognise identifying features on the vehicle and licence plate to thereby obtain identifying information which identifies the vehicle;

means for recording said identifying information in a database together with the time of day, at the time of entry of the vehicle;

means for matching said identifying information with information previously recorded in the database; and,

means for allowing or disallowing the vehicle to exit from the car park.

Preferably the intelligent car park system also includes means for allowing or disallowing the vehicle entry into the car park.

Preferably the intelligent car park system also includes:

means for calculating applicable charges for the period of time the vehicle has been parked in the car park, at the time of exit of the vehicle; and,

means for processing payment of the applicable charges or capturing credit information for future payment of such charges.

Preferably the intelligent car park system further comprises means for advising a driver of the vehicle of information relating to car park usage. Typically said advising means includes visual display means for advising the driver of, for example, the date and time of entry/exit, the vehicle licence plate, applicable charging rate, parking fees payable and instructions for payment. Optionally,

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said advising means may also include an automated audio response to enhance the delivery of information provided to the driver.

In order to facilitate a more comprehensive understanding of the nature of the invention a preferred embodiment of the intelligent car park system will now be described in detail, by way of example only, with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematic illustration of a preferred embodiment of the intelligent car park system; and

Figure 2A is a flow chart illustrating the method of controlling entry of vehicles into a car park using the system of Figure 1; and,

Figure 2B is a flow chart illustrating the method of controlling exit of vehicles from a car park using the system of Figure 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

In a preferred embodiment of the intelligent car park system (ICPS) according to the invention as illustrated in Figure 1, a plurality of computer work stations 10 and/or work station/servers 12 are interconnected via a local area network (LAN)/wide area network (WAN) or wireless data transmission system 14 or other form of computer interconnection depending on the location of the work stations and the particular requirements of the car park operator. For example, two or more car parks operated by the same operator could be controlled by the one system. Each work station 10 or work station/server 12 could be a stand alone PC or server/client configuration or combined into a single computer depending on the application. Typically, each entry and exit point of the car park(s) is provided with a work station 10 or work station/server 12 or both

combined into a single computer so entry and exit may be controlled by a single computer.

At the point of entry to or exit from the car park means are provided for detecting the presence of a vehicle about to enter or exit the car park. Such detecting means could take the form of an underground sensor (not illustrated) such as an inductive loop sensor or a vehicle weight sensor. In the illustrated embodiment, the means for detecting the presence of a vehicle is provided by one or more cameras 16 which are operatively connected to the work station 10, 12 and will automatically alert the system that a vehicle is about to enter or exit the car park when a motor vehicle appears in its field of view. The camera(s) 16 is also employed to capture at least one image of the vehicle including its licence plate which is then processed by the work station 10, 12 in order to recognise identifying features on the licence plate and vehicle and thereby obtain identifying information which identifies the vehicle.

The work station 10, 12 employs commercially available off-the-shelf or specially developed licence plate recognition (LPR) or other image processing (IP) software, which typically uses a goal-oriented iterative refinement process in order to identify features of the vehicle and/or the licence plate characters in the image. The LPR or IP software applies a combination of image processing and image recognition tools such as neural network recognisers, fuzzy logic and gray level-based character segmentation techniques in order to recognise the features and characters in various form and appearances. The system may include a knowledge base stored, for example, on disc array 18 to enable it to identify whether the vehicle falls into a particular category of motor vehicles. Based on the knowledge base in which the system is trained, the LPR or IP software maps the identifying characters and/or features into intelligent forms such as a Singapore vehicle licence plate or a Malaysia vehicle licence plate. ICPS can be provided with processing rules which will differentiate various categories of vehicle such as taxis, goods vehicles, lorries and passenger vehicles. Such

differentiation may be desirable where car parks charge different rates for different types of vehicles and also to ensure compliance with security and safety requirements for example to prohibit entry of a vehicle which is over the height limit of the car park.

The features of the vehicle and/or the licence plate characters which identify the vehicle are recorded in a database, which may be stored either in a local server 12 or in the disc array 18. At the point of entry, ICPS records the vehicle licence plate or other identifying features of the vehicle and the date and time of entry and updates the database with this information in order to facilitate the calculation of applicable charges. At the point of exit, ICPS checks against the database for each vehicle that has entered the car park and based on the information recorded with respect to such vehicle, calculates the applicable car park charges for payment.

At a point of entry of a vehicle, ICPS will obtain and record identifying information of the vehicle. Entry of the vehicle may be controlled by a boom gate 20 or other barrier in order to allow or disallow the vehicle to enter the car park. However, at the point of exit of the car park, ICPS will not allow exit such as by opening the boom gate until the applicable car park charges have been calculated, displayed to the driver and paid or accounted for or credit information has been captured for future payment of such charges. From its database, ICPS is able to identify whether a particular vehicle has a season pass. Vehicles for which season car park charges have been paid or will be paid, ie, on a monthly, quarterly or other seasonal basis, the system will allow exit without separate payment of dues at the point of exit. However, for all other vehicles ICPS will process the payment or capture credit information at the point of exit using, for example, a card terminal 22. The card terminal 22 is located on the driver's side of the vehicle and is easily accessible to the driver without having to step out of the vehicle. Card terminal 22 may be any suitable form of card reader capable of reading or processing a cash card, electronic purse, EFTPOS debit card, credit

card, or any other form of prepaid card or stored value card such as a Smart Card. Once payment has been processed or credit information has been captured for future payment, ICPS will generate a clearance signal which will automatically open the boom gate 20 to allow the vehicle to exit.

ICPS may also include means for advising the driver of the vehicle of information relating to car park usage. Thus, for example, such advising means 24 may include a visual display screen (this could be LED, LCD or plasma monitor) which may display the date and time of entry/exit, the number/character string of the vehicle licence plate, applicable charging rate, parking fees payable and instructions for payment. This can be further enhanced with an automated audio response from ICPS whenever required.

A preferred method of automatically controlling vehicle exit from a car park using the illustrated embodiment of ICPS of Figure 1 will now be described with reference to Figures 2A and 2B.

Figures 2A and 2B are flow charts illustrating the method of control employed by ICPS, which may be implemented in software which is custom-designed for a particular car park operator. Figure 2A deals with the process at the point of entry, whereas Figure 2B deals with the process at the point of exit. However it is to be understood that the actual hardware and equipment that run the process at the entry and exit points will usually be one and the same although if desired separate sets of hardware can be used. Significantly, the difference in operation at the entry and exit points is a difference in software only, so that by changing the software the entry and exit points can be interchanged and/or payment can be processed either at point of entry prior to parking the vehicle or at point of exit.

At the point of entry (refer Fig 2A), when a driver drives a vehicle to the entrance of the car park, its presence will be detected in the manner noted above, which initiates the entry routine in the ICPS at 100. An image or images of the vehicle

including the licence plate is captured using one or more cameras, and ICPS will then process the image(s) of the vehicle including the licence plate in order to recognise identifying features of the vehicle and/or characters on the licence plate using the LPR or IP software at 102, to identify the vehicle. Depending on the application, at this point ICPS can also compare the identifying information of the vehicle with information stored in a knowledge base in order to identify whether the vehicle falls into a particular category of motor vehicle, for example, a taxi, goods vehicle, lorry or an ordinary domestic passenger vehicle. In this manner, ICPS can differentiate between different categories of vehicle according to pre-programmed processing rules in order to apply different charging rates for different types of motor vehicle, as required.

When the vehicle has been identified, (and categorised), ICPS will search its database, which may be local, to enquire if the vehicle has purchased a valid season parking pass for this car park at 104. If the vehicle has a valid season parking pass, a video display screen may display the vehicle licence plate and the season parking expiry date, if applicable, at 106. An automated audio response may also be provided as required. Entry will be facilitated such as by opening a boom gate or other barrier at 108 and the driver can proceed to park the vehicle in the car park.

If the vehicle does not have a valid season parking pass, and the car park allows for daily/hourly parking, as determined at 110, the visual display screen will display the vehicle licence plate and the date and time of entry into the car park at 112, similar to 106. However, if the vehicle does not have a valid season parking pass, and the car park does not allow for daily/hourly parking, the screen will display "ENTRY DENIED" at 114, and provide instructions for departing from the area.

In an alternative embodiment the image of the vehicle is captured and processed to identify the vehicle, however, there is no means of controlling entry of the vehicle. The vehicle may drive through the entry point without having to stop.

At the exit point (refer Fig. 2B) of the car park, when a vehicle prepares to exit the car park, the process is similar but now includes calculation of the applicable charges for the period of time the vehicle has been parked in the car park, and processing payment of the applicable charges or capturing credit information for future payment. ICPS detects the presence of a vehicle waiting to exit the car park and initiates the exit routine at 120. One or more cameras capture images of the vehicle including its licence plate and ICPS processes the images of the vehicle and licence plate using the LPR or IP software at 122 in order to recognise the identifying features of the vehicle or characters on the licence plate which identify the vehicle. The process is similar to that at step 102 in the entry routine. When the vehicle is identified, ICPS will search its database in order to locate the matching record for the same vehicle stored at the time of entry, which record will include date and time of entry as well as vehicle categorisation information if applicable. ICPS then compares the date and time of exit with the date and time of entry of vehicle and calculates applicable charges for the period of time the vehicle has been parked in the car park. If the vehicle has a valid season parking pass, as determined at 124, ICPS may provide a visual display and/or audio response at 126 similar to 106. ICPS can be customised to meet individual car park requirements, so for example, where season parking is paid monthly, the audio response can provide a reminder for payment. The boom gate or other barrier is opened at 128 and the driver can proceed to exit from the car park.

If the vehicle does not have valid season parking, it is presumably on a daily/hourly parking rate, and ICPS will display car park usage information at 130. Typically, ICPS will provide a visual display of the number/character string of the vehicle licence plate, the parking period, the parking fees payable and

instructions for payment. The driver inserts a "cash card" into the card terminal and ICPS will check the card at 132 to ensure that there is sufficient credit on the card to pay for the parking fees. If there is sufficient credit on the card to pay the parking fees, ICPS will deduct the amount from the cash card at 134 and return the card to the driver. The amount of credit remaining in the cash card is simultaneously displayed on the display screen at 136. The barrier is opened at 128 and the driver can leave the car park. If there is insufficient credit on the card to pay the parking fees, ICPS will advise insufficient credit on cash card, display the balance of the card on the visual display screen at 138 and return the card to the driver. At this stage, the driver may be required to either insert another card or top up the credit on the card before attempting to exit the car park again or ICPS may allow exit after capturing credit information for future payment.

From the above description of a preferred embodiment of an intelligent car park system and method of automatically controlling vehicle entry to and exit from a car park, it will be apparent that the ICPS has a number of advantages over prior art systems, including the following:

(a) It is easy to use requiring minimal action by the driver;

(b) It provides an accurate record of car park usage, which is useful for management purposes;

(c) It facilitates rapid entry to and exit of vehicles from a car park, particularly where season parking is available;

(d) It can be customised and/or re-configured to meet individual car park requirements;

(e) It can be used by both small single car park operators as well as large multi-car park operators;

(f) The driver does not need to work with loose change or deal with parking coupons or meters for payment of car park fees or look for autopay stations; and,

(g) In terms of car park management there is increased car park security and the problems of autopay station pilferage/damage is avoided.

(h) Better payment enforcement or compliance, particularly in unmanned car parks or in places where attendants (or car park users) cannot be trusted to be completely honest.

Numerous variations and modifications will suggest themselves to persons skilled in the relevant technical arts, in addition to those already described, without departing from the basic inventive concepts. All such variations and modifications are to be considered within the scope of the present invention, the nature of which is to be determined from the foregoing description and the appended claims.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

1. A method of automatically controlling vehicle exit from a car park using a computer-based intelligent car park system, the method comprising the steps of:

detecting the presence of a vehicle about to enter or exit the car park;

capturing one or more images of the vehicle including its licence plate;

processing the image or images of the vehicle including its licence plate in order to recognise identifying features on the vehicle and licence plate to thereby obtain identifying information which identifies the vehicle; and,

at the time of entry of the vehicle to the car park, recording said identifying information together with time of entry of the vehicle; or, at the time of exit of the vehicle:

matching said identifying information with information previously recorded in the database; and,

allowing exit of the vehicle from the car park.

2. A method of automatically controlling vehicle entry to and exit from a car park comprising the steps as defined in claim 1, further comprising the step of allowing or disallowing entry of the vehicle into the car park.

3. A method of automatically controlling vehicle entry to and exit from a car park as defined in claim 2, further comprising the steps of:

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calculating applicable charges for the period of time the vehicle has been parked in the car park; and,

processing payment of the applicable charges or capturing credit information for future payment of such charges.

4. A method of automatically controlling vehicle entry to and exit from a car park as defined in claim 3, further comprising the step of comparing said identifying information with information stored in a knowledge base in order to identify whether the vehicle falls into a particular category of motor vehicle.

5. A method of automatically controlling vehicle entry to and exit from a car park as defined in claim 4, wherein said step of calculating applicable charges includes applying different charging rates depending on the category of motor vehicle.

6. A method of automatically controlling vehicle entry to and exit from a car park as defined in claim 2, further comprising the step of comparing said identifying information with information stored in a database in order to identify whether the vehicle has a season pass for using the car park, wherein the applicable charges are levied on a weekly, monthly, quarterly or other seasonal basis.

7. A method of automatically controlling vehicle entry to and exit from a car park as defined in claim 3, wherein said step of processing payment involves deducting the charges from a cash card, debit card, credit card or other stored value card.

8. A method of automatically controlling vehicle exit from a car park as defined in claim 1, further comprising at the time of entry of the vehicle the

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step of transmitting the identifying information together with the time of entry of the vehicle to a computer database by a suitable transmission means for recordal.

9. A computer-based intelligent car park system for automatically controlling vehicle exit from a car park, the system comprising:

means for detecting the presence of a vehicle about to enter or exit the car park;

means for capturing one or more images of the vehicle including its licence plate;

means for processing the image or images in order to recognise identifying features on the vehicle and the licence plate to thereby obtain identifying information which identifies the vehicle;

means for recording said identifying information in a database together with the time of day, at the time of entry of the vehicle;

means for matching said identifying information with information previously recorded in the database; and,

means for allowing the vehicle to exit from the car park.

10. An intelligent car park system as defined in claim 9, further comprising means for allowing or disallowing the vehicle entry into the car park.

11. An intelligent car park system as defined in claim 10, further comprising means for calculating applicable charges for the period of time the vehicle has been parked in the car park, at the time of exit of the vehicle; and,

means for processing payment of the applicable charges or capturing credit information for future payment of such charges.

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12. An intelligent car park system as defined in claim 11, further comprising means for advising a driver of the vehicle of information relating to car park usage.

13. An intelligent car park system as defined in claim 12, wherein said advising means includes visual display means for advising the driver of, for example, the date and time of entry/exit, the number/character string of the vehicle licence plate, applicable charging rate, parking fees payable and instructions for payment.

14. An intelligent car park system as defined in claim 13, wherein said advising means also includes an automated audio response to enhance the delivery of information provided to the driver.

15. An intelligent car park system as defined in claim 10, wherein said image processing means comprises a computer work station programmed with image processing software, including licence plate recognition software.

16. An intelligent car park system as defined in claim 11, wherein said payment processing means includes a card terminal capable of reading or processing a cash card inserted in the card terminal by a driver at the point of exit of the car park.

17. An intelligent car park system as defined in claim 10, wherein said vehicle detecting means includes an underground vehicle sensor.

18. An intelligent car park system as defined in claim 10, wherein said image processing means, recording means, matching means and calculating means are provided in connection with a plurality of computer workstations capable of communication with each other via a wireless transmission system or a local/wide area network or other form of computer interconnection.

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19. An intelligent car park system as defined in claim 10, further comprising means for transmitting the identifying information together with the time of entry of the vehicle to a computer database via a wireless transmission system or a local/wide area network or other form of computer interconnection.

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