PARKABLE POSITION DISPLAY SYSTEM

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to a system for displaying the position of a vacant parking space (which position will be referred to hereinafter as a parking space position) in an outdoor parking area or in a roofless open-air parking area located on the rooftop of a building, and more particularly to a system of the kind described above in which image information regarding the presence or absence of a parking space and the position thereof is provided for a car driver intending to park his car in such a parking area, so that cars already entered the parking area and those waiting in the vicinity of the parking area can be automatically guided thereby making smooth the flow of cars entering and leaving the parking area.

DESCRIPTION OF THE RELATED ART

Three types of the system of this kind have hitherto been proposed. In the first type of the system, sensors for counting the numbers of cars entering and leaving a parking area are disposed at the entrance and exit of the parking area so as to merely grasp the number of cars parked in the parking area. In the second type of the system, a TV camera is provided to image the entire area of a parking area, and the image signal generated from the TV camera is subjected to digital image processing so

as to detect a vacant parking space by identifying the presence of an object having the shape of a car in the parking space. In the third type of the system, a moving object is continuously detected and tracked by means of image processing, and information regarding a car which has entered or left a parking space is stored in a memory.

However, the first type of the system, in which the numbers of cars entering and leaving a parking area are merely counted, is defective in that the position of a vacant parking space is not immediately detected, and a car cannot be immediately guided toward the vacant parking space. Also, the first type has the problem that, once the system is reset during its operation, it becomes necessary to count and register the number of cars again at the time of re-starting the operation. Further, in the case of the first type of the system, an error of the count of the number of cars inevitably accumulates after a long period of operation. Therefore, it is necessary to improve the accuracy of the sensors or it is necessary to periodically count the actual number of cars so as to correct the count of the number of cars stored in a memory provided in the system.

On the other hand, in the case of the second type of the system resorting to the identification of the object having the shape of a car by means of the image processing, it is difficult to simply extract the features of cars having a variety of shapes, and an attempt to improve the accuracy of identification leads to the complexity of image

processing and leads also to an increased period of time required for the image processing. Also, the improvement in the accuracy of identification is not so easy, and there is the possibility that a parking space already occupied by a car may be mistaken as vacant.

Further, in the case of the third type of the system resoring to the detection and tracking of a moving object by means of image processing, this image processing will not be effective unless it is continuously repeated as in the case of the first type in which the numbers of cars entering and leaving a parking area must be continuously counted. Therefore, the third type has the problem that, once accurate detection of a moving object entering or leaving a parking space is failed, this wrong decision on the specific parking space remains until another moving object will enter or leave this parking space next time.

US-A-4346293 describes a sensing arrangement which comprises a light transmitter and receiver spaced apart above a parking space. The transmitter transmits a light beam downwardly at an angle to the vertical. If no vehicle is present in the space a reflected beam is received at the receiver. If a vehicle is present the receiver does not receive a reflected beam.

SUMMARY OF THE INVENTION

With a view to solve such prior art problems, it is an object of the present invention to provide a parking space position display system in which the

position of a vacant parking space in a car parking area is detected by means of single still image processing, so that the position of this vacant parking space is displayed for a car driver who wants to park his car in the parking areas.

According to the present invention there is provided a parking space position display system comprising a TV camera for imaging a symbol or a character marked in each of parking spaces of a car parking area, A/D conversion means for converting the image output signal of said TV camera into digital data, memory means for storing the digital data as a still image, extraction means for extracting said

symbols or said characters from the still image, detection means for detecting the positions of vacant parking spaces on the basis of said symbols or said characters extracted by said extraction means, and display means for displaying the vacant parking spaces detected by said detection means.

The symbol may be in the form of a single circle is marked in each of parking spaces, and these circular symbols are confirmed so as to detect and display the positions of vacant parking spaces.

The symbol may be in the form of a concetric multiple circle is marked in each of the parking spaces, and the number of concentric circles and the ratios of the line distances between the concentric circles are identified so as to detect and display the positions of vacant parking spaces.

A character can be marked in each of the parking spaces, and these characters identified by collation with character patterns stored in a character dictionary so as to detect and display the positions of vacant parking spaces.

A plurality of mirrors may be displaced around the car parking area, and the image of the parking area is taken together with those reflected in the mirrors so as to detect and display the positions of vacant parking spaces.

The TV camera may be mounted on a balloon floating above the car parking area to take the image of the parking area, and the imaging conditions are determined on the basis of a plurality of reference patterns disposed around the parking area so as to detect and display the positions of vacant parking spaces.

The positions of vacant parking spaces may be marked on a still image taken by the TV camera and then converted into analog data so as to display the positions of vacant parking spaces on a display monitor.

Therefore, a parking space position display system constructed in accordance with the present invention is advantageous in that, although a symbol or a character marked in a parking space occupied by a car is hidden by the car, the symbol or character is revealed again when the car leaves the parking space, and, by extracting the revealed symbol or character and confirming the specific symbol or character on the still image, vacant parking space position information for a car can be provided.

The parking space position display system can be so constructed that, although the problem of a dead angle arises during imaging by the TV camera due to the presence of cars in a plurality of parking spaces, this dead angle is eliminated by the use of the mirrors or by the

movement of the TV camera together with the floating balloon, so that the symbol or character in each vacant parking space can be definitely confirmed.

A parking space position display system which includes the display monitor for displaying spaces based on the analog data is advantageous in that, when the position of a vacant parking space detected as a result of confirmation of the symbol or character in that parking space is marked on the still image taken by the TV camera and is displayed on the monitor, a parking attendant or a car driver intending to park his car in the parking area is readily informed of the position of the vacant and parkable parking space.

The invention will be described now by way of example only, with particular reference to the accompanying drawings. In the drawings:

Fig. 1 is a block diagram showing the structure of an embodiment of the vacant parking space position display system according to the present invention.

Figs. 2 and 3 are plan views showing different states of one form of a parking area provided with the vacant parking space position display system shown in Fig. 1.

Fig. 4 is a block diagram showing the structure of another embodiment of the vacant parking space position display system according to the present invention.

Figs. 5 and 6 are plan views showing different states of one form of a parking area provided with the vacant parking space position display system shown in Fig. 4.

Figs. 7A, 7B and 7C are plan views of various actual examples of the symbol used in the parking area shown in Figs. 5 and 6.

Fig. 8 is a block diagram showing the structure of still another embodiment of the vacant parking space position display system according to the present invention.

Figs. 9 and 10 are plan views showing different states of one form of a parking area provided with the vacant parking space position display system shown in Fig. 8.

Figs. 11 to 14 are plan views showing various other examples of the character used in the parking area shown in Figs. 9 and 10.

Figs. 15 to 17 are plan views showing other forms respectively of a parking area provided with the vacant parking space position display system of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows the structure of an embodiment of the vacant parking space position display system according to the present invention. This embodiment is applied to a parking area in which a symbol in the form of a single circle is marked in each of parking spaces.

Referring to Fig. 1, a camera lens unit 1 is attached to the front of a TV camera 2. A general control unit 3 controls the operation of the entire system. A lens control unit 4 carries out remote control of the iris

etc. in the camera lens unit 1. An A/D converter unit 5 converts an image signal from the TV camera 2 into digital data. A still image memory unit 6 stores the digital image data as a still image. A circular symbol extraction unit 7 extracts the positions of circles from the still image stored in the still image memory unit 6. A circular symbol confirmation unit 8 confirms that circles are extracted by the circular symbol extraction unit 7. When a complete circle is not confirmed, a correction processing unit 9 decides whether such an incomplete circle results from partial shading of a circle by a car parked in a parking space in front of the specific parking space marked with the circle or a car is already parked in that parking space. In the former case, the correction processing unit 9 makes necessary correction so that the specific parking space is decided to be vacant. A result-of-decision transmission unit 10 counts the sum, of the number of the confirmed circles and the number of the corrected circles and transmits the count to a car guiding unit 13. The unit 10 acts also to mark vacant parking spaces on the still image stored in the still image memory unit 6. A D/A converter unit 11 converts the marked still image into an analog image signal. A display monitor unit 12 displays the analog image signal on a TV screen.

Fig. 2 shows one form of the symbol used in the parking area, and it will be seen in Fig. 2 that a circle "○" is marked in each of parking spaces 14 for cars. The reference numeral 15 indicates an example of the

position of location of the TV camera 2. In Fig. 2, the TV camera 2 is located on the rooftop of a building or on a pole erected at the center of the parking area. Fig. 2 shows that no cars are parked in the parking area. On the other hand, Fig. 3 shows that cars are parked in nine parking spaces 14, and the TV camera 2 located above the parking area can recognize or detect none of the circles marked in the nine parking spaces 14 because the circles are hidden by the cars.

The operation of the embodiment shown in Fig. 1 will now be described. When cars enter the parking area and are parked in the individual parking spaces 14 in the state of the parking area where all of the circles marked in the parking spaces 14 can be recognized as shown in Fig. 2, the circles corresponding to the number of the cars parked in the nine parking spaces 14 cannot be recognized.

The entire parking area is imaged by the TV camera 2 at intervals of a predetermined period. In this case, the iris, etc. of the camera lens unit 1 are remotely controlled by the lens control unit 4. The image of the parking area taken by the TV camera 2 is converted by the A/D converter unit 5 into a digital signal, and this signal is stored as a still image in the still image memory unit 6. In this case, the still image is stored at intervals of a predetermined period of, for example, 1 sec to 5 sec. The still image read out from the still image memory unit 6 is supplied to the circular symbol extraction unit 7, and the portions corresponding to the circular

symbols in the image are extracted to be supplied to the circular symbol confirmation unit 8. The extracted positions represent the positions of the circular symbols in the parking spaces 14 and indicate the positions of the possible parking spaces 14. The circular symbol confirmation unit 8 confirms whether the true circles indicating the vacant parking spaces 14 are extracted from the image. When a complete circle is not confirmed, the correction processing unit 9 decides whether such an incomplete circle results from partial shading of the circle by the car parked in the parking space in front of the specific parking space or the car is already parked in that parking space. In the former case, the correction processing unit 9 makes necessary correction to decide that such a parking space is vacant and transmits the result of decision to the result-of-decision transmission unit 10. The result-of-decision transmission unit 10 counts the number of vacant parking spaces confirmed by detection of the circles and transmits that information together with the position information to the car guiding unit 13. This unit 10 acts also to mark the total number and positions of the vacant parking spaces on the still image stored in the still image memory unit 6. The marked still image is converted by the D/A converter unit 11 into an analog image signal which is displayed as a TV image on the dispaly monitor unit 12. On the basis of the TV image displayed on the display monitor unit 12, the car guiding unit 13 informs the total number and positions of vacant parking

spaces for cars, so that the cars can be guided toward the vacant parking spaces.

The image from the TV camera 2 is supplied and stored in the still image memory unit 6 at intervals of, for example, 1 sec, and the circular symbols in the image are confirmed, so that the positions of parking spaces 14 vacant at the time of 1 sec before can be detected. The display monitor unit 12 displays the vacant parking spaces 14 so that the position information of such vacant parking spaces 14 can be provided for cars entering the parking area.

According to the illustrated embodiment, the positions of vacant parking spaces at the time of imaging can be simply detected by single still image processing. Therefore, the TV camera 2 need not be continuously operated, and the single TV camera 2 that may be mounted on the center pole erected on the parking area may be panned so that it exhibits the effect of a plurality of TV cameras. Also, because the object of image processing is not cars having a variety of shapes but is simple circle, the positions of vacant parking spaces can be recognized by simple processing. Also, pattern rotation processing is unnecessary because such circular symbols can be recognized as circles when viewed from whatever angles although they may be somewhat distorted. Also, it is not generally supposed that the circular symbol marked in each parking space can be detected when a car is parked in that parking space. (It is commonly rarely

practical that a large circle is marked on the roof of a car.) Therefore, the possibility of providing wrong information to guide a car toward an already occupied parking space is very low, and accurate information can be surely provided. Further, because the same circle is marked in each of all the parking spaces, the painting work can be facilitated.

Fig. 4 shows another embodiment of the present invention in which a concentric multiple circle is used as the symbol. The embodiment shown in Fig. 4 includes a symbol extraction unit 21 extracting the position of a concentric multiple circle, and a symbol recognition unit 22 recognizing the number of concentric circles and the ratios of the line distances between the concentric circles extracted by the symbol extraction unit 21. The remaining components are similar to those shown in and described by reference to Fig. 1 and need not be described in detail here.

Fig. 5 shows one form of a parking area to which the embodiment shown in Fig. 4 is applied, and it will be seen that each of parking spaces 14 for cars are marked with a concentric multiple circle indicating its position. The same concentric multiple circle may be used for each of these parking spaces 14 or different concentric multiple circles may be used for the respective parking spaces 14. The reference numeral 15 indicates an example of the position of location of a TV camera 2. In Fig. 5, the TV camera 2 is located on the rooftop of a building or

on a pole erected at the center of the parking area. Fig. 5 shows that no cars are parked in the parking area. On the other hand, Fig. 6 shows that cars are parked in nine parking spaces 14, and the TV-camera 2 located above the parking area can recognize or detect none of the concentric multiple circles marked in the parking spaces 14 because the concentric multiple circles are hidden by the cars. In Figs. 5 and 6, a concentric double circle which is a simplified form of the concentric multiple circle is shown. Figs. 7A, 7B and 7C show actual examples of a variety of the concentric multiple circles. Fig. 7A shows a concentric quintuple circle in which the diameter ratios of the concentric circles are the same. Fig. 7B shows a concentric quadruple circle in which the diameter ratios of the concentric circles are different from each other. Fig. 7C shows an arrangement of two concentric multiple circles in which an upper quadruple circle and a lower quintuple circle have different ratios of line distances between the concentric circles, respectively.

The operation of this second embodiment applied to the parking area using the multiple circles marked in the parking spaces is basically the same as that of the first embodiment applied to the parking area using the single circles marked in the parking spaces. Referring to Fig. 4, the symbol extraction unit 21 extracts the concentric multiple circular symbols from a still image stored in a still image memory unit 6 and supplies the extracted

symbols to the symbol recognition unit 22. The symbol recognition unit 22 recognizes the ratios of the line distances between the concentric circles and the number of the concentric circles in a manner similar to the detection of bar codes well known in the art, thereby deciding whether or not the extracted symbols truly represent the concentric multiple circles indicating the vacant parking spaces. If an extracted symbol is not recognized as a complete multiple circuit, a correction processing unit 9 decides whether such an incomplete multiple circle results from partial shading of a multiple circle by a car parked in a parking space in front of the specific parking space marked with the multiple circle or a car is parked in that parking space. In the former case, the correction processing unit 9 makes necessary correction so as to restore the multiple circle which indicates that the parking space is vacant. The operations of the remaining units are the same as those described already by reference to Fig. 1 and will not be described in detail here.

According to this second embodiment, the single TV camera mounted on, for example, the center pole is panned so that the parking area capable of parking several-ten to several-hundred cars can be monitored by the single TV camera. Also, the positions of vacant parking spaces at the time of imaging can be simply detected by single still image processing. Especially, because the object of image processing is not cars having a variety of shapes

but is simple multiple circles which are symmetrical when viewed from various angles, pattern rotation processing is unnecessary. Therefore, when the change between black and white is noted, the multiple circles can be extracted by relatively simple image processing. Thus, the scale of the system can be reduced, and a single image processing unit can process images taken by a plurality of TV cameras, so that the system can deal with a large-capacity parking area. Also, it cannot be generally supposed that the multiple circular symbol marked in each parking space can be detected when a car is parked in that parking space. Therefore, the possibility of providing wrong information to guide a car toward an already occupied parking space is very low, and accurate information can be surely provided. Further, when the number of the concentric circles and the ratios of the line distances between the concentric circles are selected to differ in the individual parking spaces, the absolute position of a specific parking space can be readily identified, and a car can be guided toward this specific parking space.

Fig. 8 shows a third embodiment of the present invention. In this third embodiment, Arabic numerals are used as identification characters for identifying the positions of parking spaces in a parking area. Referring to Fig. 8, the system comprises a character extraction unit 23 extracting the position of an Arabic-numeral character from a still image, a character rotation unit 24 orienting the direction of the extracted character in a

predetermined direction, and a character recognition unit 25 enlarging or contracting the size of the extracted character according to the size of characters stored in a character dictionary 26 so as to recognize the extracted character by collation with those stored in the character dictionary 26. In this character dictionary 26, Arabic numeral patterns marked in the parking spaces are stored. In the case of a parking area shown in Fig. 9, the character dictionary 26 stores Arabic numerals 1 to 48. The remaining components of the third embodiment are the same as those shown in Fig. 1 or 4 and need not be described in detail here.

As described above, the numerals 1 to 48 are marked in the respective parking spaces 14 shown in Fig. 9. The reference numeral 15 designates the position of location of the TV camera 2. This TV camera 2 is mounted on the rooftop of a building or on a pole erected at the center of the parking area. Fig. 9 shows that no cars are parked in the parking spaces. On the other hand, Fig. 10 shows that cars are parked in nine parking spaces numbered 4, 5, 6, 14, 15, 16, 31, 40 and 45, and the TV camera 2 cannot recognize these numerals because these numerals are hidden by the cars parked in these parking spaces.

The operation of this third embodiment is basically the same as that of the embodiment shown in Fig. 1 or 4 except the operations of the character extraction unit 23, the character rotation unit 24 and the

character recognition unit 25. When cars enter the parking area and are parked in the individual parking spaces 14 in the state of the parking area where all of the numerals marked in the parking spaces 14 can be recognized as shown in Fig. 9, the numerals corresponding to the number of the cars parked in the nine parking spaces 14 cannot be recognized as shown in Fig. 10. The image of the parking area taken by the TV camera 2 is converted by the A/D converter unit 5 into a digital signal, and this signal is stored as a still image in the still image memory unit 6. From the still image read out from the still image memory unit 6, the character extraction unit 23 detects the positions of characters corresponding to vacant parking spaces and orients the detected characters in the predetermined direction. For example, the direction of the numerals 1 to 12 and that of the numerals 13 to 24 are opposite to each other in Fig. 9. Therefore, in order to recognize these numerals, it is necessary to rotate one of these numeral groups by 180° relative to the other so as to orient them in the same direction, and the character rotation unit 24 acts to change the direction. The characters oriented in the same direction by the function of the character rotation unit 24 are supplied to the character recognition unit 25, and, after their size is enlarged or contracted to meet the size of the characters stored in the character dictionary 26, they are collated with the characters stored in the character dictionary 26. The character recognition unit 25 recognizes whether or not

the characters correspond to those marked in the parking spaces 14. When any one of the characters cannot be completely recognized, the result-of-decision transmission unit 10 decides whether such an incomplete character results from partial shading by a car parked in the parking space in front of that parking space or the presence of a car in that parking space. In the former case, the unit 10 decides that the specific parking space is vacant and supplies the number and positions of the recognized vacant parking spaces together with those of the already confirmed parking spaces to the car guiding unit 13. At the same time, the unit 10 applies an instruction signal to the still image memory unit 6 so that the parking spaces decided as vacant are to be marked on the still image stored in the still image memory unit 6. Thus, the position information of teh vacant parking spaces can be provided for cars entering the parking area.

Figs. 11 to 14 show other forms of character display. In Figs. 11 to 14, the characters marked in the parking spaces are modified so as to facilitate the processing by the character extraction unit 23, the character rotation unit 24 and the character recognition unit 25 which is connected to the character dictionary 26.

The manner of character display shown in Fig. 11 can be used when the total number of the parking spaces is less than 100. In Fig. 11, the number of digits of all the characters is limited to two so as to simplify the character extraction by the character extraction unit 23

and so as to decrease the number of the character patterns stored in the character dictionary 26 to be used for character recognition by the character recognition unit 25. Thus, the manner of character display intends to improve the accuracy of character recognition, to shorten the period required for processing and to reduce the contents of the character dictionary 26 which is the character pattern memory.

In the character display shown in Fig. 12, one of the letters of the alphabet is combined with one of the Arabic numerals 1 to 9 to represent each parking space, and this form can deal with the case where the total number of the parking spaces exceeds 100. In this case, it is preferable not to use the Arabic numeral 2 and the letter Z of the alphabet which are analogous to each other.

In the character display shown in Fig. 13, a two-stage arrangement, in which one of the letters of the alphabet is displayed in an upper position and one of two-digit numerals is displayed in a lower position, is used to represent each parking space. The employment of such an arrangement can deal with an increase in the total number of parking spaces in a parking area and can also deal with the numbering of parking spaces in a parking area where more than 10 cars are parked in each row of the parking spaces. Although the number of kinds of the characters and the total number of the characters to be recognized increase as compared to the case shown in Fig. 11, the accuracy of decision of the positions of vacant

parking spaces, when recognized, is improved.

In the character display shown in Fig. 14, an underline is additionally marked under each of character combinations so as to facilitate the decision of the rotation angle for character rotation processing by the character rotation unit 24. This manner of character display is advantageous in that not only the rotation processing is simplified but also a mistake between the numerals 6 and 9 can be prevented.

In this third embodiment too, the positions of vacant parking spaces at the time of imaging can be simply detected by single still image processing. Therefore, the TV camera need not be continuously operated, and the single TV camera that may be mounted on the center pole erected at the center of the parking zone may be panned so that it exhibits the effect of a plurality of TV cameras. Also, because the object of image processing is not cars having a variety of shapes but is simple Arabic numerals and letters of the alphabet, characters can be recognized by relatively simple processing. Also, even when recognition of a character may be mistaken, the mistaken character can be easily corrected by estimation on the basis of the result of recognition of adjacent vacant parking spaces. Further, it is not generally supposed that the character marked in each parking space can be detected when a car is parked in that parking space. Therefore, the possibility of providing wrong information to guide a car toward an already occupied parking space is very low, and accurate

information can be surely provided.

Fig. 15 shows another form of a parking zone, and it will be seen that each of parking spaces 14 for cars is marked with a concentric multiple circle indicating its position. The reference numeral 15 indicates the position of location of a TV camera 2. In Fig. 15, the TV camera 2 is located on the rooftop of a building or on a pole erected at the center of the parking zone. The arrangement shown in Fig. 15 is the same as that shown in Fig. 5. In the case of the parking area shown in Fig. 15, a plurality of mirrors 16 are disposed around the parking area.

The operation of the third embodiment will now be described. When cars enter the parking area and are parked in the individual parking spaces 14 in the state of the parking area where all of the multiple circles marked in the parking spaces 14 can be recognized as shown in Fig. 15, the multiple circles corresponding to the number of the cars parked in the parking spaces 14 cannot be recognized. In this case, the multiple circle marked in the parking space behind one of the cars may be shaded when the image of the parking area is directly taken by the TV camera 2, and there is the possibility that the system may decide that a car is already parked in that parking space. This possibility of making a wrong decision depends on the size of the parking space, the height of the shading car and the height of location of the TV camera 2. In this embodiment, the image reflection from the mirrors 16 located in front of the TV camera 2 or adjacent mirrors

16 is utilized so as to avoid making such a wrong decision attributable to the cars parked in front of or adjacent to the specific parking spaces. The image from the TV camera 2 is supplied to the A/D converter unit 5. For example, the image is taken at intervals of 1 sec and stored in the still image memory unit 6, and, on the basis of recognized multiple circular symbols, the positions of vacant parking spaces at the time of 1 sec before can be detected. During the image processing, the direction of the TV camera 2 is changed to be zoomed up toward one of the mirrors 16, and, after 1 sec, the image is stored in the still image memory unit 6 so as to carry out processing for recognizing the multiple circles. The operation for changing the direction of the TV camera 2 toward the mirror 16 is repeated so as to detect vacant parking spaces, and the positions of the vacant parking spaces are indicated by the car guiding unit 13, so that the information regarding the vacant parking spaces can be provided for cars entering the parking area.

Fig. 16 shows that oscillating mirrors 17 are provided to replace the stationary mirrors 16 so as to decrease the number of the mirrors.

Multiple circular symbols are used in Figs. 15 and 16, but circular or any other suitable symbols or the letters of the alphabet and Arabic numerals may be used. However, because the image reflected from the mirrors 16 or 17 is inverted in all the directions from the actual image, it is preferable to use a symbol such as a circle

or a multiple circle which is symmetrical in all the directions.

According to the illustrated arrangement, whether a parking space is vacant or not can be decided by imaging the reflection from the mirrors even when such a parking space is shaded by a car and cannot be directly imaged by the TV camera 2.

Fig. 17 shows still another form of a parking area to which the present invention is applied. In the form shown in Fig. 17, a TV camera 2 is mounted on a balloon so as to image the entire area of the parking zone. In Fig. 17, a multiple circular symbol is marked at the center of each of parking spaces 14. The reference numerals 27 to 30 designate reference patterns used for determination of the zoom ratio of the TV camera 2 and the position of imaging by the TV camera 2. These reference patterns 27 to 30 for the TV camera 2 may be of the same kind. For example, a multiple rectangular symbol as shown at 27 may be used for all of the patterns 27 to 30.

A signal processing system similar to that shown in Fig. 4 is provided. In this case, a camera lens unit 1 attached to the TV camera 2 and a control unit 4 are mounted on or suspended from the lower part of the balloon. The balloon may be exclusively used for imaging purpose or may act also as an advertising balloon.

In operation, when cars enter the parking area and are parked in the individual parking spaces 14 in the

state of the parking area where all of the multiple circles marked in the parking spaces 14 can be recognized as shown in Fig. 17, the multiple circles corresponding to the number of the cars parked in the parking spaces 14 cannot be recognized. In this case, the range of imaging by the TV camera 2 may deviate from the parking area when the imaging position is displaced due to swaying of the balloon by wind. Therefore, the camera reference patterns 27 to 30, which are never hidden, are detected, and, under control of the lens control unit 4, the direction of the TV camera 2 and the zoom ratio as well as the focus of the camera lens 1 are adjusted so as to stabilize the imaging position. The image signal from the TV camera 2 is applied to the A/D converter unit 5, and the still image is stored in the still image memory unit 6 at intervals of, for example, 1 sec so as to recognize the multiple circular symbols, thereby recognizing the positions of parking spaces vacant at the time of 1 sec before. While the image is being processed, the direction of the TV camera 2 is changed on the basis of the camera reference patterns 27 to 30, and, after 1 sec, the image taken by the TV camera 2 is stored in the still image memory unit 6 so as to carry out the processing for the recognition of the multiple circles again. The operation for changing the direction of the TV camera 2 is repeated so as to detect vacant parking spaces. The detected positions of the vacant parking spaces are displayed on the display monitor unit 12, and, on the basis of the position display, the car

guiding unit 13 provides the position information of the vacant parking spaces for cars entering the parking area.

In this embodiment, the TV camera 2 is mounted on the balloon floating above the parking area. Therefore, the TV camera 2 can take the image of all the parking spaces of the parking area without being affected by cars parked in the parking area, so that vacant parking spaces 14 can be accurately detected.

It will be apparent from the foregoing description of preferred embodiments, the present invention provides various advantages which will be described now.

According to the first aspect of the present invention, the positions of vacant parking spaces at the time of imaging can be simply detected by single still image processing. Especially, the object of image processing is not cars having a variety of shapes but is symbols having simple shapes or specific characters so that such symbols or characters can be extracted by relatively simple image processing when the change between black and white is noted. Therefore, the processing for detection of vacant parking spaces can be carried out at a high speed, and the scale of the system can be greatly reduced.

According to the second and third aspects of the present invention, pattern rotation processing is unnecessary because the symbols marked in the parking spaces are the same when viewed from whatever angles.

According to the fourth aspect of the present

invention, the characters are marked in the parking spaces according to a rule, so that, even when one of them may not be correctly recognized or may be mistaken, such a character can be estimated or corrected on the basis of adjacent characters already recognized.

According to the fifth and sixth aspects of the present invention, the dead angle due to cars already parked in the parking spaces is eliminated, so that the symbols or characters marked in vacant parking spaces can be accurately and reliably detected.

According to the seventh aspect of the present invention, the parking attendant or a car driver who wants to park his car in the parking area can be readily informed of the position of vacant parking spaces.

CLAIMS:

1. A parking space position display system comprising a TV camera for imaging a symbol or a character marked in each of parking spaces of a car parking area, A/D conversion means for converting the image output signal of said TV camera into digital data, memory means for storing the digital data as a still image, extraction means for extracting said symbols or said characters from the still image, detection means for detecting the positions of vacant parking spaces on the basis of said symbols or said characters extracted by said extraction means, and display means for displaying the vacant parking spaces detected by said detection means.

2. A parking space position display system according to Claim 1, wherein, when said symbol marked in each parking space is a circle, said detection means includes circular symbol confirmation means for confirming that said extracted symbols are circles, and correction processing means for deciding, when one of said extracted symbols cannot be confirmed as a circle by said circular symbol confirmation means, whether the parking space is vacant or full and , when the result of a decision proves that a car can be parked therein, correcting said extracted symbol.

3. A parking space position display system according to Claim 1, wherein, when said symbol marked in each parking space is a multiple circle consisting of a plurality of concentric circles having suitably selected ratios of

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the line distances between the concentric circles, said detection means includes symbol recognition means for recognizing the number of the concentric circles and the line distance ratios of said extracted symbols, and correction processing means for deciding, when one of said extracted symbols is not recognized as a multiple circle, whether the parking space is vacant or full, and, when the result of a decision proves that a car can be parked therein, correcting said extracted symbol.

4. A parking space position display system according to Claim 1, wherein, when a character in the form of an Arabic numeral and/or the letter of the alphabet is marked in each parking lot, said detection means includes character rotation means for orienting the direction of said characters in a predetermined direction, character dictionary means for storing all the character patterns marked in the parking spaces, and character recognition means for enlarging or contracting the size of said characters oriented by said character rotation means to the size of the characters stored in said character dictionary means and collating said oriented characters with those stored in said character dictionary means thereby recognizing said characters.

5. A parking space position display system according to Claim 1, wherein a plurality of mirrors are disposed around the parking area, and said TV camera images also reflection from said mirrors.

6. A parking space position display system according

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to Claim 1, wherein said TV camera is mounted on a balloon floating above the parking area, and a plurality of reference patterns are provided around the parking area so as to be used as the reference for determination of the zoom ratio and the imaging position of said TV camera.

7. A parking space position display system according to Claim 1, wherein said display means includes marking means for marking, on the still image stored in said still image memory means, the positions of the vacant parking spaces detected by said detection means, D/A conversion means for converting the image read out from said memory means into analog data, and display monitor means for displaying said analog data as the still image.

8. A parking space position display system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.