Method for managing and maintaining license plate recognition systems in toll areas

Comprises calculating, for each exit station of said toll, a quality level of several image acquisition devices included in a license plate recognition system which covers all the entry stations which can be the origin of said exit station, i.e., it comprises the possible stretch or stretches of traveled course preceding the exit station in question, by means of performing the following steps:
- acquiring values of certain operating parameters of the cameras of each of said origin entry stations; and
- applying in each exit station, on said acquired values of the origin entry stations, a function including said operating parameters to obtain a quality level parameter, or NC parameter, for each exit station.
Description

Field of the Art

[0001] The present invention relates to a method for the management of license plate recognition systems in toll facilities, in which a supervision task is performed which includes matching up the image of a vehicle in an entry toll station with that of the same vehicle in an exit station, using in each entry and exit station an image acquisition system integrating at least one camera, associated lighting means and an electronic system or equipment suitable for performing optical character recognition on the acquired images.

[0002] The invention contributes in said field (license plate recognition systems) a method which provides at all times quantifiable information concerning the quality level of said cameras and the status of the communications of said cameras with the electronic system to validate the mentioned data matching and contribute to an increased reliability of the system.

Prior State of the Art

[0003] Patent US 4 774 571 describes a computerized ticket dispensing system in which each toll station includes a camera for reading the license plate of a vehicle at its entry in or exit from the station, in order to determine in an individualized manner the moment of entry and the moment of exit of each vehicle, an information processing system further having been provided which includes consultable databases associated with each entry and with each exit, intended for verifying the incidents of the toll. The time of entry and exit of the vehicles is determined by means of the mentioned cameras.

[0004] In turn, application EP 1 914 686 describes a vehicle license plates registration system and a method for the management of the obtained information, comprising means like those in the aforementioned US patent and also a processing unit intended to subsequently match the license plate data of each vehicle at its entry and exit from the toll road for the purpose of verifying traffic conditions.

[0005] Application US 2004/165750 also describes details concerning a system like those described above.

[0006] However there is no reference or suggestion of any sort in the background documents which considers a control of the efficacy or efficiency and/or availability of the means used (mainly cameras) to acquire and transmit the information to the evaluation and/or control centers, such that the transmitted information can include inaccuracies or errors which will significantly affect the quality of the evaluation.

Description of the Invention

[0007] For this reason it is necessary to provide an alternative to the state of the art which covers the voids existing therein in relation to the lack of methods or systems for evaluating operating conditions, and particularly the reliability and efficiency of the means involved in the detection (cameras, lighting devices, etc.), analysis and transmission of vehicle recognition data, contemplating a network of toll roads or highways.

[0008] For this purpose, the present invention relates to a method for the management of license plate recognition systems in toll areas, each of said systems being of the type comprising for each entry station one or more image acquisition devices, each of which integrates a camera with lighting means associated therewith connected with an electronic system suitable for performing an optical character recognition, or OCR, on the images acquired by said or said cameras by means of a set of suitable programs.

[0009] The method of the present invention proposes calculating at any time for each exit station the quality level of the cameras included in at least one license plate recognition system, or LPRS system, which covers all the entry stations which can be the origin of said exit station, i.e., comprising the possible stretch or stretches of traveled course preceding the exit station in question, by means of performing the following steps:

- acquiring values of certain operating parameters of the cameras and generally of the image acquisition devices of each of said origin entry stations;
- applying in each exit station, on said acquired values of the origin entry stations, at least one function (integration or summation) including said operating parameters of all the entry stations involved, to obtain a quality level parameter, or NC parameter, for each exit station.

[0010] Thus, the proposed NC parameter numerically condenses the status of the entire license plate recognition system, seen from a chosen determined exit station, such that by consulting it, it is possible to get an idea of the veracity of the data returned for each exit lane analyzed, and acting accordingly (for example repairing the cameras, lighting system or signal transmission means) if said data show that the cameras included in the license plate recognition system associated with said exit lane, i.e., it covers all the entry stations which can be the origin of the exit station of said exit lane, do not have a sufficient quality level to consider the data inferred from the images acquired thereby as valid.

[0011] Concerning the mentioned operating parameters for each camera or group of cameras, they relate to:

- communication status, for the purpose of detecting the cameras without a response or with an unsuitable signal or image; and/or
- license plate recognition rate or reliability of the OCR detection, for the purpose of indicating the cameras the values of which are under a determined minimum cutoff value, which is configurable.
[0012] The proposed method is applied to a closed toll area including at least one exit lane and several entry lanes, with their respective toll stations and each of said entry lanes provided with license plate recognition servers (data processing equipment) and at least one traveled course server which receives the information of said license plate recognition servers.

[0013] According to the method proposed by the invention, each license plate recognition server will be in charge of maintaining these values and of reporting to the traveled course server periodically. The management of the NC parameter is thus simplified in the traveled course server because it only has to take into account the values supplied by the recognition servers (one value for each of them, or in any case for each station).

[0014] To that end, the method comprises performing, by means of each license plate recognition server associated with or located in each entry station, and every certain time period, said acquisition of values of said operating parameters for the cameras managed by the same, and each of said license plate recognition servers applying on the acquired values a first function to obtain a respective quality level parameter nc_server.

[0015] For one embodiment, the method comprises each license plate recognition server acquiring said operating values asynchronously and periodically integrating them with previously known or acquired values, weighting the values with the time for which they are valid to obtain said nc_server.

[0016] In other words, in a first step, each license plate recognition server monitors the status of the cameras it controls in the respective entry lanes (covering at least communication status, recognition rate or reliability of the detection), and periodically, for a period T, said server integrates the information of the status it is aware of by means of applying said first function, and which it has received asynchronously, weighting it with the time for which each controlled status has been valid, status being understood as being that associated with the corresponding value for each of the operating parameters in relation to predetermined cutoff values which have been configured.

[0017] The value of said nc_server is representative of a mean of the cameras which work correctly with respect to the total entry cameras controlled by each license plate recognition server, weighted by the time that each of said acquired operating parameter values is maintained. This value will be a number between 0 and 1.

[0018] The method comprises sending the nc_server value included in each period T from each license plate recognition server to said traveled course server, for example by means of a remote procedure call, or RPC, message every time the end of a period T is reached.

[0019] The method also comprises, every time there is a change in the operating parameters or conditions of the cameras, communicating to each license plate recognition server the new values of the operating parameters that have changed, provided certain predetermined conditions are met, which for one embodiment are the following:

- the reported value has changed by more than a predetermined percentage with respect to that previously sent to the license plate recognition server; and
- a predetermined time has lapsed since sending the last value of each operating parameter.

[0020] A certain hysteresis is thus applied to the process of communicating the operating parameter status or values of the cameras, thus assuring that the nc_server value will not constantly change due to isolated incidents with a single vehicle.

[0021] For one embodiment, the method comprises sending said nc_server values and said operating parameter values asynchronously by means of different remote procedure call, or RPC (TCP/IP communication protocol), messages.

[0022] Once the different nc_server values have reached the traveled course server, for example by means of the aforementioned RPC messages, the method comprises said traveled course server calculating a series of values (n) of a final quality level parameter for each entry station and for each exit station (taking into account the associated origin entry stations), or nc_{ej} values (i = number of entry stations and j = number of the exit station) from the received nc_server values, for a total time window in turn made up of several periods T.

[0023] According to an embodiment, the method comprises calculating said nc_{ej} by applying a correction to said received nc_server values by means of several sets of coefficients which link each of the exit and entry stations. There will thus be in a database a set of curves (represented by a series of static and configurable coefficients) for each of the exit stations corresponding to all the entry stations.

[0024] The physical meaning of these coefficients is the distance ratio existing between an exit station and all the origin entry stations, as well as the time it takes for a journey between each pair of stations, previously evaluating it by taking into consideration, for example, the mean speeds of the different vehicles depending on their category. The magnitude of distance/time is thus transferred to the probability that the origin of exit traffic is a determined entry station given a time interval, depending on the time it can take from each of the possible origins and on the existing distance to each of them. The information of the traffic density of a roadway is also reflected by means of these weighting coefficients.

[0025] Once the values corresponding to all the nc{ej} are available, the method comprises said traveled course server calculating a total quality level parameter value NC_{TOTALj} for each of j exit lanes, or for each group of exit lanes, from said nc{ej} values, by means of the following formula:
where \( e_i \) refers to the entry station, \( e_j \) to the exit station, and \((k_i \cdot k'_i)\) are indicative of different weights assigned to each of the recognition servers, each assigned weight being made up of the product of the following two factors:

- \( k \) is a configurable factor or coefficient which is given by parameters of the corresponding station selected from the group comprising the following parameters: daily mean intensity (DMI), number of lanes, and the proximity to a large town or city, or a combination thereof.
- \( k' \) is a configurable factor or coefficient which is given by the calculated probability of the origin from one of the determined exit stations \( j \).

Preferably, the method comprises including in said formula all the \( n \) \( c_{eij} \) values with the exception of those corresponding to \( i=j \), i.e., with the exception of those belonging to the same station in which the exit lane \( j \) is located so that the \( NC_{TOTAL} \) value is being given, and/or, depending on the embodiment, also with the exception associated with an entry station \( e_i \) incompatible with the exit lane \( j \).

The method comprises updating as frequently as possible, preferably at all times, this \( NC_{TOTAL} \) value for each of the exit stations. As has been described, this parameter is calculated depending on a series of factors affecting the reliability of the data provided.

In the event that there is any problem with this mechanism, manual configuration is possible. The new lanes would always be assigned by default, and as long as they are not assigned to a substation or station, to the first existing substation or station.

The previously described calculation of \( NC_{server} \) is communicated to the lanes and to an operating center or Central Level as part of the information returned to a petition relating to exit traffic.

For one embodiment, every time it is necessary to return a \( NC_{TOTAL} \) value, the last stored value corresponding to the group of exit lanes in which the lane in question is located is accessed.

Brief Description of the Drawings

The foregoing and other advantages and features will be fully understood from the following detailed description of several embodiments with reference to the drawings, which must be considered as being illustrative and non-limiting, in which:

Detailed Description of Several Embodiments

First in reference to Figure 1, it shows \( n \) series of time slots within a period \( T \), each of which includes a respective quality parameter or \( n_{ci} \) value (specifically five: \( n_{c0} \) to \( n_{cN-1} \)), which is representative of the different operating parameters of the cameras associated with a license plate recognition server.

For one embodiment, every time it is necessary to return a \( NC_{TOTAL} \) value, the last stored value corresponding to the group of exit lanes in which the lane in question is located is accessed.

As with the entry lanes, the exit lanes can be clustered by servers and/or stations (or substations). For the stations in which there are two license plate recognition servers installed, this clustering of lanes is independent of the machine which provides support for the OCR process for the images provided by the corresponding cameras (the link between camera and OCR is given by the address of the SFTP server which is configured in each camera).

To automatically maintain the configuration of the substations, the invention proposes using a currently unused field of a general configuration file (CONF file) of the toll road or highway operating companies. This file, which is received in the traveled course server, is structured as follows:
for a period T from the mean of the cameras which work correctly weighted by the time that each of said nc values is maintained is expressed in Figure 1 by the following mathematical expression:

$$\frac{\sum_{i=0}^{n-1} t_i \cdot nc_i}{\sum_{i=0}^{n-1} t_i},$$

which will result in a number between 0 and 1.

[0038] According to the method proposed by the invention, the initial status starts from \( nc_{server} = 100 \) (maximum quality), and every time the period T is met and is reported to a higher level, i.e. to the traveled course server, it continues with the last known value.

[0039] With respect to the calculation of the different \( nc_{eisj} \) values performed in the traveled course server, Figure 2 graphically illustrates said calculation, showing the aforementioned total time window used in said calculation, which has a depth configurable in periods T, and which in this case specifically includes thirty-two periods T.

[0040] Though the T value will be configurable, the invention proposes starting from a value of fifteen minutes, so the total window of Figure 2, i.e., \( t_{TOTAL} \), corresponds to eight hours.

[0041] For each entry station \( i \) associated with an exit station \( j \), the thirty-two \( nc_{server} \) values, indicated as \( nc_{serverT0} \) to \( nc_{serverTN-2} \), each of which corresponds to a period T, are shown. The application of thirty-two correction coefficients which link each of the exit and entry stations, to obtain the thirty-two corresponding \( nc_{server} \) parameter values for the total window, is sought to be graphically depicted by means of the triangle illustrated on the \( nc_{serverTN-2} \) parameters.

[0042] Said Figure 2 shows the last period differently from the others, particularly transversely traversed by a vertical band because this period is subjected to a special treatment. In the event of a notification of a change of the \( nc_{serverN-1} \) parameter before the period ends being received during said period, said special treatment particularly consists of the latter being treated as if it were a complete period.

[0043] Finally, Figure 3 shows the different steps of the method proposed by the present invention for one embodiment.

[0044] The first two steps shown in said Figure 3 are carried out in the license plate recognition servers associated with each entry station, the first step consisting of calculating the different \( nc_{servers} \) (indicated as \( (nc_{server}) Ti \)), and the second step consisting of communicating by means of RPC messages said values after each period T (the integral indicates the clustering or summation of the different \( nc_{servers} \)). The next three steps are carried out in the traveled course server, and consist of calculating the \( nc_{eisj} \) values, the \( NC_{TOTAL} \) values and finally including them in an informative file "infoNC".

[0045] Figure 4 shows the explained representative function of the quality level, from a first exit station of a toll road, in successive entry stations. It can be seen that said function shifts along the mentioned temporal window fractioned into 32 periods, being calculated at all times in correspondence with said entry stations.

[0046] A person skilled in the art will be able to introduce changes and modifications in the described embodiments without departing from the scope of the invention as it is defined in the attached claims.

Claims

1. A method for the management and maintenance of license plate recognition systems in toll areas, each of said systems being of the type comprising at least one image acquisition device integrating a camera with lighting means connected with an electronic system suitable for performing an optical character recognition, or OCR, on the images acquired by said at least one camera, and signal transmission means of said cameras, the method being characterized in that for each exit station, a quality level of said image acquisition devices included in at least one license plate recognition system is calculated, said calculation covering all the entry stations which can be the origin of said exit station, or traveled course stretch preceding same, by means of performing the following steps:

- acquiring values of certain operating parameters of the cameras of each of said origin entry stations;
- applying in each exit station, on said acquired values of the origin entry stations, at least one function including said operating parameters to obtain a quality level parameter, or NC parameter, for each exit station; and
- acting on the cameras, lighting means or signal transmission means of any one of the entry stations which can be the origin of said exit station, depending on the mentioned quality level NC parameter, to repair one or more elements of said stations to make the quality level parameter allow considering the data inferred from the acquired images as valid.

2. The method according to claim 1, characterized in that said operating parameters are, for each camera or group of cameras of an entry station, values relating to:

- camera communication status, including image provided and signal quality;
- license plate recognition rate or reliability of the
3. The method according to claim 2, characterized in that it is applied to a closed toll area which includes at least one exit lane and several entry lanes, with their respective toll stations and license plate recognition servers associated with each entry station, and at least one traveled course server which receives the information from said recognition servers.

4. The method according to claim 3, characterized in that it comprises performing, by means of each license plate recognition server of each entry station, and every certain time period, said acquisition of values of said operating parameters for the cameras managed by the same, and each of said license plate recognition servers applying on the acquired values a first function to obtain a respective quality level parameter nc_server.

5. The method according to claim 4, characterized in that it comprises acquiring, by means of each license plate recognition server, said values asynchronously and periodically integrating them with previously known or acquired values, weighting the values with the time for which they are valid to obtain said nc_server.

6. The method according to claim 5, characterized in that the value of said nc_server is representative of a mean of the cameras which work correctly with respect to the total entry cameras controlled by each license plate recognition server, weighted by the time that each of said acquired values of the operating parameters is maintained.

7. The method according to claim 5, characterized in that it comprises sending said nc_server values from each license plate recognition server to said traveled course server periodically.

8. The method according to claim 7, characterized in that it comprises, every time there is a change in the operating parameters or conditions of the cameras, communicating to each license plate recognition server the new values of the operating parameters that have changed, provided certain predetermined conditions are met.

9. The method according to claim 8, characterized in that said predetermined conditions are the following:
   - the reported value has changed by more than a predetermined percentage with respect to that previously sent to the license plate recognition server; and
   - a predetermined time has lapsed since sending the last value of each operating parameter.

10. The method according to any one of claims 6 to 9, characterized in that it comprises sending said nc_server values and operating parameter values by means of messages.

11. The method according to any one of claims 6 to 10, characterized in that it comprises said traveled course server calculating a series of values (n) of a final quality level parameter for each entry station i and each exit station j, or nc_eisj values, from the received nc_server values, for a configurable, previously established total time window.

12. The method according to claim 11, characterized in that it comprises calculating said nc_eisj by applying a correction to the received nc_server values by means of coefficients which link each of the exit and entry stations.

13. The method according to claim 12, characterized in that said coefficients refer to the distance ratio existing between an exit station and all the origin entry stations thereof, as well as to the mean time it takes for a journey between each pair of stations.

14. The method according to claim 13, characterized in that it comprises said traveled course server calculating a total quality level parameter value NC_TOTAL_j for each of the j exit lanes, or for each group of exit lanes, from said nc_eisj values, by means of the following formula:

\[
NC_{TOTAL_j} = 100 \times \frac{\sum_{i=1}^{n} (k_i \cdot k_i' \cdot nc_{eisj})}{\sum_{i=1}^{n} (k_i \cdot k_i')}
\]

where ei refers to the entry station, ej to the exit station, and \((k_i, k_i')\) refers to different weights assigned to each of the recognition servers, each assigned weight being made up of the product of two factors:

- k is a configurable factor or coefficient which is given by parameters of the corresponding station selected from the group comprising the following parameters: daily mean intensity (DMI), number of lanes, and the proximity to a large town or city, or a combination thereof.
- \(k'\) is a configurable factor or coefficient which is given by the calculated probability of the origin given an exit station.

15. The method according to claim 14, characterized in that it comprises including in said formula all the nc_eisj values with the exception of those corresponding to i=j and/or of those associated with an entry station.
station $e_i$ incompatible with the exit lane $j$. 
Fig. 1

\[ \sum_{\text{lanes}} \left( \sum_{\text{ok}} \text{cam}_{\text{com}} \wedge \text{cam}_{\text{ref}} \text{ok} \right) \]

Changes in the quality parameters of the cameras

\[ \sum_{i=0}^{n} t_i \cdot n_c \]

nc last period T (OCR serv.)

\[ \sum_{i=0}^{n} t_i \]

Fig. 2

\[ \forall i, i \in E \]

32 coefficients (entry i / exit j)

32 coefficients (entry i / exit j)

T (15 min)

t_{\text{TOTAL}} (32T, 8 h)
Recognition Servers

\[ \int dt \]

Paso 1

RPC

\( (n_{\text{server}1})_{T_1} \)

\[ \int dt \]

Paso 2

RPC

\( (n_{\text{server}2})_{T_1} \)

\[ \int ds \]

Paso 3

\( (n_{\text{city}}) \)

\( (n_{\text{TOTAL}}) \)

Traveled Course Server

Paso 4

\( \text{infoNC} \)

Paso 5

\( \text{infoNC} \)

\( \cdots \)

\( \cdots \)

PROGRESSION

Fig. 3

Highway Stretch

Station 1

\( n_{\text{TOTAL}} = 100 \times \frac{\sum_{i=1}^{4} (k_i \cdot k_i \cdot n_{e,s_i})}{\sum_{i=1}^{4} (k_i \cdot k_i)} \)

time function

Station 2

Station 3

Station 4

Fig. 4
### DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>X</td>
<td>US 2009/208059 A1 (GEVA AMIR [IL] ET AL) 20 August 2009 (2009-08-20)</td>
<td>1-14</td>
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The present search report has been drawn up for all claims

**Examiner:** Van der Haegen, D

Place of search: The Hague

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For more details about this annex: see Official Journal of the European Patent Office, No. 12/82
REFERENCES CITED IN THE DESCRIPTION

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