



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication: **12.05.2010 Bulletin 2010/19** (51) Int Cl.: **G07B 15/00 (2006.01)**

(21) Application number: **08168829.3**

(22) Date of filing: **11.11.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

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(54) **Road pricing system**

(57) Method for pricing the use of a public road system etc. by vehicles, called road pricing. Each vehicle (1) is provided with vehicle processing means (2), which are arranged for assessing and transmitting data related to motions of the vehicle along or through the road system, called motion data (m). The road system comprises means (3) for storing road data (r). Pricing processing means (4) are provided for processing the motion data (m) received from each individual vehicle into individual pricing data (p). The vehicle processing means (2) transmit the vehicle's motion data (m) to the pricing processing means (4). The pricing processing means (4) calculate the pricing data (p) using the received motion data (m)

and the related road data (r) and return the calculated pricing data (p) to the vehicle processing means (2) of the relevant vehicle (1). The vehicle processing means (2) receive the pricing data (p) and make them available to someone responsible for declaring the road pricing. A verification authority (5) transmits in time changing verification codes (v) to the pricing processing means, which are linked to road sections. Vehicle identifiers, e.g. license plates, of passing vehicles are recorded by cameras, together the time. When the pricing data (p), calculated by the price processing means, are returned to the vehicle processing means (2), the verification codes which correspond to the road sections and times the vehicle moved along, are added to those pricing data.

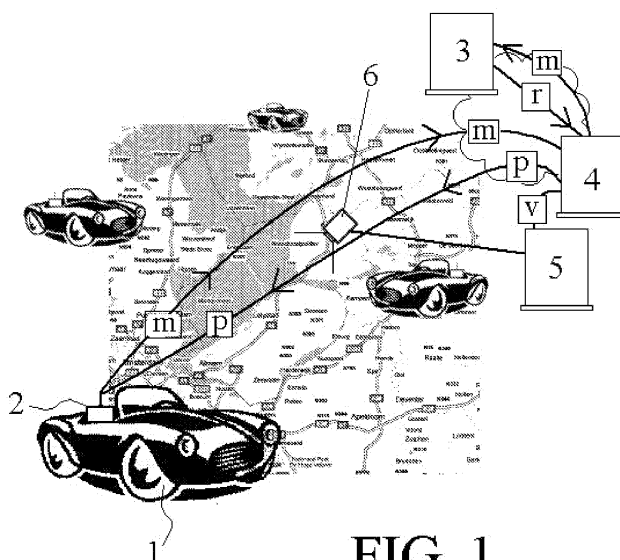


FIG. 1

Description

[0001] The invention refers to a method for pricing and/or billing for the use of a public road system etc. by vehicles, called road pricing hereinafter.

[0002] One aim is to provide a method and means respectively in which the privacy of each individual (vehicle) user will be guaranteed. Another aim is to provide a method and means respectively in which as much as possible central processing capacity is used, while the processing capacity in each vehicle is minimal. Moreover there is no need for communication between the vehicle and road-side equipment. Both aspects implicate the possibility of cheap on-board-equipment.

[0003] According to the invention a method and means respectively are proposed for pricing and/or billing for the use of a public road system etc. by vehicles (often called road pricing), comprising:

- providing each relevant vehicle with vehicle processing means, which are arranged for:
 - assessing and transmitting data related to motions of the vehicle along or through the road system, called motion data hereinafter, and e.g. consisting of pairs of (t_i, x_i) where t_i is the time of the measurement with index i and x_i is the (3-dimensional) position of the measurement, not necessarily on a road element;
 - receiving pricing data related to the vehicle and its motions,
- providing the public road system with means for storing data related to the public road system and/or sections of it, like individual roads etc., called road data hereinafter;
- providing pricing processing means for processing the motion data received from each individual vehicle into individual pricing data,

wherein:

- the vehicle processing means transmit the vehicle's motion data, however, not its vehicle data, to the pricing processing means;
- the pricing processing means calculate the pricing data using the received motion data and the related road data and return the calculated pricing data to the vehicle processing means of the relevant vehicle;
- the vehicle processing means receive the pricing data and make them available to a person or authority who/which is responsible for the declaration or payment of the road pricing of the vehicle.

[0004] The data related to the vehicle and/or its owner, called vehicle data hereinafter, may also be stored in the vehicle processing means and be used (see last step above), together with the received pricing data, to calcu-

late, declare or pay, by the responsible person or authority the road pricing of his/her/its vehicle. The vehicle data, however, may be stored and used separately, e.g. within a PC or (via any terminal) within any Internet accessible server.

[0005] To ensure or enhance the privacy aspect of the method, is preferred that the vehicle processing means transmit the vehicle's motion data to the pricing processing means in an anonymized way, e.g. by data (block) partitioning and scrambling or any form of data (block) desequencing, which prevents reconstruction of private or sensitive information from the data exchanged between the vehicle processing means and the price processing means.

[0006] One aspect is to provide a method and means respectively for registration the numbers of kilometres driven by vehicles in a privacy friendly way, which need can be fulfilled by the above measures, which will be elucidated more in detail further below.

[0007] Another aspect is to provide a method and means respectively for verifying -by a verification or enforcement authority- whether the users indeed use the road pricing as prescribed.

[0008] For the latter aspect it is preferred that the following steps are performed:

- a verification authority transmits verification codes to the pricing processing means, which verification codes are linked to all sections of the road system, in particular those sections where vehicle identifiers, e.g. license plates, of passing vehicles are recorded, e.g. by photo or video cameras, together with a time indication, e.g. timestamps, of such recordings;
- when the pricing data, calculated by the price processing means, are returned to the vehicle processing means of the relevant vehicle, the verification codes which correspond to the road sections and times the vehicle moved along or through, are added to those pricing data;
- after the vehicle processing means receive the pricing data and the relevant verification codes and make them available to the person or authority responsible for the declaration or payment of the road pricing of the vehicle, that person or authority adds the vehicle's identifier, e.g. license number, and the received verification codes to his/her/its declaration or payment of the road pricing of the vehicle;
- the verification authority compares the received declaration or payment, including the vehicle's identifier and the verification codes with its own records of verification codes and links to the times and sections of the road system where the identifiers of passing vehicles were recorded.

[0009] The pricing means preferably comprise two components to ensure, in collaboration with the vehicle processing means, the privacy aspect. The price processing means processes, in a first step, the motion

data, using the especially geometrical road data, into a trajectory, i.e. a set of pairs (t_i, x_i) where the x_i is the best fitting point on a geometrically described road element and i is an index. In a second step it processes the trajectory into the prices for driving on the respective road elements (sections). It is preferred to use a privacy agent to ensure the impossibility for the price processing means to derive information related to the privacy or sensitive aspects of the vehicle's motions. The three parties, i.e. the vehicle processing means, the price processing means and the privacy agent are able to guarantee the privacy aspect for the user. The vehicle processing means communicate in an anonymous way with the price processing means, e.g. akin to the way a prepaid GSM communicates with a GSM provider. The provider only knows that 'someone' has paid for an amount of services (in this case: geometrical fitting and pricing service). The price processing means receive the motion data via the privacy agent, fulfils its service task and sends again via the privacy agent its data back to the vehicle processing means. So the privacy agent has the task to work as an intermediate party between the vehicle processing means and the price processing means: it receives the motion data of the vehicle processing means in such a way that it can not interpret the motion, only the times of the measurements. It sends packets of the motion data (e.g. in parts of five minutes) to the price processing means, gets back data on the road segments plus the price of the driving on the road segments plus verification codes -all in a unintelligible way-, pastes the packets of the motion in the right (predefined) way and sends the information to the vehicle processing means. In this way it is secured that only the vehicle processing means know the complete motion of the car. The price processing means only know that "someone drove at a certain road segment". The privacy agent only knows that the car drove, but not where.

[0010] Hereinafter the invention will be exemplified using attached figure 1, which gives a schematic and exemplary illustration of a system which is arranged to perform the method according to the invention.

[0011] Figure 1 shows a number of cars 1 driving along a public road system. Each car 1 is provided with a rather simple car module 2, arranged for assessing -by means of a position measuring system, e.g. GPS- and transmitting data related to motions of the car along or through the road system, indicated as motion data m in figure 1, and for receiving, and (temporarily) storing, pricing data p related to the car and its motions.

[0012] The public road system is provided with a server 3 for storing data related to the public road system and/or sections of it, like individual roads etc., called road data r hereinafter. Such a server 3 may already be in use for other purposes, e.g. for road management and maintenance etc. A pricing server 4 is provided for processing the motion data m received from each individual car into individual pricing data p .

[0013] In operation, the car module 2 transmit the car's

motion data m (without its car data like license number etc.) to the pricing server 4. The pricing server 4 calculates the pricing data p , using the received motion data m and the related road data r , retrieved from road server 3 using those motion data m , and returns the calculated pricing data p to the car module 2 of the relevant car 1. The car module 2 receives the pricing data p and makes them available to a person or authority who/which is responsible for the declaration or payment of the road pricing of the car, the car user or owner.

[0014] The data related to the car and/or its owner/user, called car data v hereinafter, may or may not be stored in the car module. If stored in the car module 2, it can be used, together with the received pricing data p , to calculate, declare or pay, by the responsible person or authority the road pricing of his/her/its car. If the car data v is not stored in the car module 2 it may be stored in e.g. the owner's or user's PC, which can be used to declare or pay the road pricing to the Tax Authority (not shown in the figure). The pricing data p -and optionally the car data v - can be transferred to the user's or owner's PC by means of a USB stick or via wired or wireless (e.g. IR, Bluetooth etc.) communication, if necessary by using authentication tools.

[0015] It is preferred that the car module 2 transmits the car's motion data m to the pricing server 4 in an anonymized way, e.g. by data partitioning and scrambling or any form of data desequencing, causing that individual car trips cannot feasibly be tracked, or by introducing a privacy agent in between (not shown in the figure).

[0016] For verifying or enforcement, to prevent fraud with the declaration of trips to the Tax Authority, a verification authority 5 transmits verification codes to the pricing server 4, which verification codes are linked to sections of the road system (hence not linked with the cars on it).. These verification codes are not intelligible for the vehicle processing means, nor for his owner or any other than the verification authority (for instance by encryption). Along the road system car identifiers, e.g. license plates, of passing cars are recorded, e.g. by photo or video cameras 6. When the pricing data p , calculated by the pricing server, are returned to the car module 2 of the relevant car 1, the verification codes which correspond to the road sections at the time the car moved along or through them, are added to those pricing data. The data are stored in the car module 2 in a secure way as long as necessary.

[0017] After the car module 2 receives the pricing data p and the relevant verification code(s) both are made available to the person or authority responsible for the declaration or payment of the road pricing of the car, which person or authority adds the car's identifier, e.g. license number, and -for instance on explicit demand of the verification authority- the received verification codes to his/her/its declaration or payment of the road pricing of the car. The verification authority checks the received declaration or payment, including the car's identifier and the presence of the right (see also the example below) verification codes with its own records of verification

codes and links to the sections of the road system where the identifiers of passing cars were recorded.

[0018] Suppose a vehicle having license number AA-99-BB, drives from A to B. The vehicle's car module 2 detects the vehicle's motion (in fact outcomes of measurements of time and coordinates) along its path A-B and transmit the car's motion data *m* (without its license number) to the pricing server 4. The road server 3 has subdivided the road network into rather short road sections which are coded into section codes. The pricing server 4 calculates the pricing data *p*, using the received motion data *m* and the related road data *r*, retrieved from road server 3 using those motion data *m*, and returns the calculated pricing data *p* to the car module 2 of the relevant car 1. The car module 2 receives the pricing data *p* and makes them available to a person or authority who/which is responsible for the declaration or payment of the road pricing of the car, the car user or owner. The pricing data e.g. includes a dataset like:

License AA-99-BB	
Date/time	Section code
4-11-2008 09:00	FeuZiyfp
4-11-2008 09:02	8AhFhSvu
4-11-2008 09:03	G7CiD4gw
4-11-2008 09:05	RZNdGe9G
4-11-2008 09:09	anx7NpSJ
4-11-2008 09:10	EG7ffTRV
4-11-2008 09:14	vecdoawQ
4-11-2008 09:16	i8wtPvbk
4-11-2008 09:17	RP9vpBFe
4-11-2008 09:20	nAzP4w7R
4-11-2008 09:22	WCGq6nts
4-11-2008 09:25	7ao2uRKK
4-11-2008 09:27	x7NDcudX
4-11-2008 09:29	5LPFiFRK
4-11-2008 09:32	axM5eRdR
4-11-2008 09:35	mEQZg5Ab
4-11-2008 09:37	cedYZhLq
4-11-2008 09:39	wNCNfnrM
Etc.	Etc.

[0019] The road section codes may be used as verification codes for verifying, to prevent fraud with the declaration of trips to the Tax Authority. To that end the verification authority 5 transmits the verification/section

codes to the pricing server 4, which verification codes thus are linked to the sections of the road system in particular those where -for verification reasons- the license plates of passing cars may be recorded, e.g. by photo or video cameras 6. When the verification authority 5 installs such a "check point" 6 at a certain road section, e.g. at road section **WCGq6nts**, during a certain period, e.g. at 2008-11-04 between 09:00 and 10:00, the verification 5 authority changes the code of that road section, e.g. from **WCGq6nts** into **SUgbJq6j**. Due to that code change the data set should have look like:

License AA-99-BB	
Date/time	Section code
4-11-2008 09:00	FeuZiyfp
4-11-2008 09:02	8AhFhSvu
4-11-2008 09:03	G7CiD4gw
4-11-2008 09:05	RZNdGe9G
4-11-2008 09:09	anx7NpSJ
4-11-2008 09:10	EG7ffTRV
4-11-2008 09:14	vecdoawQ
4-11-2008 09:16	i8wtPvbk
4-11-2008 09:17	RP9vpBFe
4-11-2008 09:20	nAzP4w7R
4-11-2008 09:22	SUgbJq6j
4-11-2008 09:25	7ao2uRKK
4-11-2008 09:27	x7NDcudX
4-11-2008 09:29	5LPFiFRK
4-11-2008 09:32	axM5eRdR
4-11-2008 09:35	mEQZg5Ab
4-11-2008 09:37	cedYZhLq
4-11-2008 09:39	wNCNfnrM
Etc.	Etc.

[0020] So when the pricing data *p*, calculated by the pricing server, are returned to the car module 2 of the relevant car 1, the verification codes which correspond to the road sections at the time the car moved along or through them, are added to those pricing data.

[0021] After the car module 2 receives the pricing data *p* and the relevant verification code(s) both are made available to the person or authority responsible for the declaration or payment of the road pricing of the car, which person or authority adds the car's identifier, e.g. license number, and -for instance at explicit demand of the verification authority- the received verification codes

to his/her/its declaration or payment of the road pricing of the car. The verification authority compares the received declaration or payment, including the car's identifier (AA-99-BB) and the verification codes with its own records of verification codes and links to the sections of the road system where the identifiers of passing cars were checked. So in this exemplary case the verification authority only needs to check whether or not for the user's license number **AA-99-BB**, the section code **SUgbJq6j** is present in the user's declaration or payment. If that code should not be present in the dataset the submitted declaration proves to be fraudulent (after all car **AA-99-BB** was gatsoed driving over road section **SUgbJq6j**), after which the Tax Authority can take measures in consequence of that.

[0022] In fact the verification authority will change the codes of the road segments (not only of the segments where license plates are recorded) frequently -e.g. four times a day at varying times- to prevent interpreting of the codes.

[0023] It is noted that in the preceding the right road section code only has been printed in bold for reason of intelligibility; of course in practice this will not be done within the dataset sent to the vehicle processing means.

[0024] In this way a method has been disclosed which provides in sophisticated road pricing for the real use of vehicles, using modern means.

Claims

1. Method for pricing and/or billing for the use of a public road system etc. by vehicles, called road pricing hereinafter,

- providing each relevant vehicle (1) with vehicle processing means (2), which are arranged for:

- assessing and transmitting data related to motions of the vehicle along or through the road system, called motion data (m) hereinafter;

- receiving pricing data (p) related to the vehicle and its motions,

- providing the public road system with means (3) for storing data related to the public road system and/or sections of it, like individual roads etc., called road data (r) hereinafter;

- providing pricing processing means (4) for processing the motion data (m) received from each individual vehicle into individual pricing data (p);

the method comprising next steps:

- the vehicle processing means (2) transmit the vehicle's motion data (m), however, not its ve-

hicle data, to the pricing processing means (4);
- the pricing processing means (4) calculate the pricing data (p) using the received motion data (m) and the related road data (r) and return the calculated pricing data (p) to the vehicle processing means (2) of the relevant vehicle (1);
- the vehicle processing means (2) receive the pricing data (p) and make them available to a person or authority who/which is responsible for the declaration or payment of the road pricing of the vehicle.

2. Method according to claim 1, wherein data related to the vehicle and/or its owner, called vehicle data (v) hereinafter, is stored in the vehicle processing means and used, together with the received pricing data (p), to calculate, declare or pay, by the responsible person or authority the road pricing of his/her/its vehicle.

3. Method according to claim 1, wherein the vehicle processing means (2) transmit the vehicle's motion data (m), to the pricing processing means (4) in an anonymized way, e.g. by data partitioning and scrambling or any form of data desequencing or in the way a prepaid GSM communicates with a GSM provider.

4. Method according to claim 1, comprising the following steps intended for verifying or enforcement:

- a verification authority (5) transmits verification codes to the pricing processing means, which verification codes are linked to sections of the road system where vehicle identifiers, e.g. license plates, of passing vehicles are recorded, e.g. by photo or video cameras, together with a time indication, e.g. timestamps, of such recordings;

- when the pricing data (p), calculated by the price processing means, are returned to the vehicle processing means (2) of the relevant vehicle (1), the verification codes which correspond to the road sections and times the vehicle moved along or through, are, e.g. only on explicit demand of the verification authority, added to those pricing data;

- after the vehicle processing means (2) receive the pricing data (p) and the relevant verification codes and make them available to the person or authority responsible for the declaration or payment of the road pricing of the vehicle, that person or authority adds the vehicle's identifier, e.g. license number, and the received verification codes to his/her/its declaration or payment of the road pricing of the vehicle;

- the verification authority compares the received declaration or payment, including the ve-

hicle's identifier and the verification codes with its own records of verification codes and links to the sections of the road system where the identifiers of passing vehicles were recorded.

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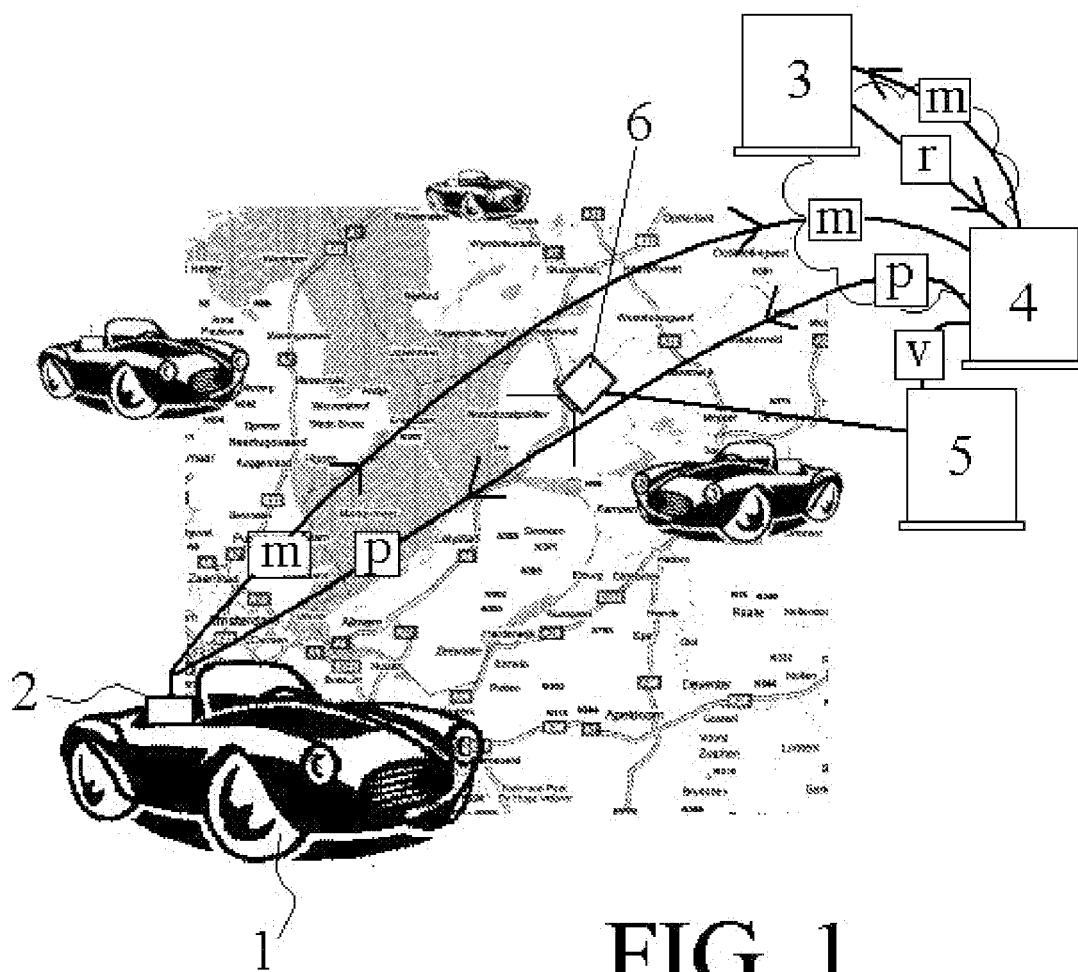


FIG. 1



EUROPEAN SEARCH REPORT

Application Number
EP 08 16 8829

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 31 March 2009	Examiner Toader, Elena Lidia
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503.03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 16 8829

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