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A SYSTEM FOR LOCATING TRANSPONDERS IN AN INSTALLATION FOR
REMOTE PAYMENT OF MOTORWAY TOLLS

The invention relates to a system for locating a
transponder which is moving along a road having a certain
width.

Such a system is more particularly intended for a
multilane motorway remote two payment installation that
includes a camera-based security system which
automatically identifies vehicles that cheat by taking
pictures of the number plates of such vehicles that fail
to pay.

In that kind of remote payment installation,
vehicles travelling on the motorway network are fitted
with respective transponders (generally located behind
the windshield) capable of communicating with beacons
mounted on a gantry spanning the road at a toll section.
Each transponder may include a prepaid card from which
deductions are made as the transponder passes beneath the
gantry as a result of a transaction between the
transponder and a control center connected to the
beacons.

To identify vehicles that fail to pay, e.g. those
that do not have a transponder or those in which the
balance stored in the prepaid card has been exhausted, it
is necessary to locate each transponder rather accurately
as it passes beneath the gantry in order to be able to
associate it with a vehicle.

The object of the invention is to provide a system
for laterally locating a transponder passing beneath a
toll gantry for remote payment, i.e. a system for
determining the position of the transponder relative to
one of the sides of the road.

To this end, the invention provides a system for
locating a transponder travelling along a road of a
certain width, the system being characterized in that it
comprises:

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a set of beacons each suitable for communicating with the transponder if it is located in a communications zone specific to the beacon under consideration and of a width that is smaller than the width of the road, the beacons being distributed in line across the road so that the communications zones of the beacons overlap in pairs and together they cover the entire width of the road; and

control means acting cyclically on the beacons to cause them to transmit signals for establishing communication between themselves and a transponder passing through at least at least one of the beacon communications zones, which control means detect which beacon or beacons have established such communication with the transponder and associate the detected beacon(s) with a certain portion of the width of the road indicative of the lateral position of the transponder across the road, said control means activating said beacons in a sequence such that two adjacent beacons do not transmit simultaneously.

It can be seen that this localization system is particularly simple to implement. It makes use merely of beacons that are already in place for performing remote payment transactions. Its accuracy increases with increasing number of beacons and with increasing precision and localization of the communications zones of the beacons.

The localization system is described in greater detail below and is shown in the drawing.

Figure 1 is highly diagrammatic and shows a remote toll payment installation for a multilane motorway and using a localization system of the invention.

Figure 2 is highly diagrammatic and shows how a transponder is located in accordance with the invention by using beacons.

Figure 3 shows how portions of road width are associated with the beacons.



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In Figure 1 a remote toll payment installation on a multilane motorway (i.e. having a plurality of lanes in parallel) comprises a microwave communications system based on beacons B and on transponders T suitable for communicating with one another, remotely.

The beacons B are disposed on a gantry 1 spanning the parallel lanes along which vehicles move. Below, reference is made to a single lane only, representative of the parallel lanes beneath the gantry 1.

Each vehicle travelling along the toll road must be fitted with a transponder T which is generally fixed behind the vehicle windshield, as shown in Figure 1.

Each transponder T comprises a transceiver and electronics for controlling an electronic prepayment card to deduct a certain sum from the card as a result of a transaction being performed between the transponder passing beneath the gantry and a control center which is connected to the transceiver beacons.

The installation also includes a picture-taking system that includes cameras such as 2 placed upstream from the gantry 1 in the vehicle travel direction for the purpose, in this case, of photographing the back number plates of the vehicles passing beneath the gantry in order to make it possible to catch vehicles that fail to pay. Other cameras may be provided to photograph the front number plates of the vehicles.

Infrared, laser, or similar detectors such as 3 are placed on the gantry 1 to detect the passage of vehicles and to locate them. More particularly, these detectors 3 are distributed at a plurality of detector curtains (three curtains in Figure 1) extending across the road, thereby enabling them to perform localization both across the road and along the road.

According to the invention, the communications system based on beacons B and transponders T is used for laterally locating each transponder passing beneath the gantry. Such lateral location is necessary in order to



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be able to associate a transponder with a vehicle (itself located using the detectors 3) for the purpose of catching vehicles that fail to pay. In general, vehicles that fail to pay are identified as follows:

- 5 * transactions are performed with transponders passing beneath the gantry;
- * a dated geometrical track of each transponder is located;
- * a dated geometrical track of each vehicle is
- 10 located;
- * transponder tracks and vehicle tracks are associated;
- * vehicles that fail to pay which are associated with transponders that do not pay are identified
- 15 directly; and
- * vehicles that fail to pay and that are not associated with transponders are identified differentially.

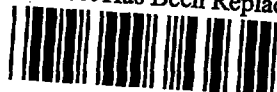
20 The system for laterally locating a transponder T or a plurality of transponders T coming under the gantry 1 in parallel thus makes use of the communication that takes place between the beacons and the transponder(s).

25 More particularly, in this system, the beacons B are distributed across the road and they are regularly spaced apart. Each beacon B has a communications zone whose three-dimensional shape is substantially egg-shaped and which forms an ellipse S on the ground.

30 Figure 2 shows six beacons B1 to B6 which are distributed across the width L_r of the road 4. The number of beacons is merely illustrative. Each beacon is suitable for communicating with a transponder moving in its own communications zone. The communications zones of the beacons B1 to B6 are represented by ellipses S1 to S6. It can be seen in Figure 2 that the communications

35 zones of the beacons are of small width l_s that is smaller than the width L_r of the road 4.

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The beacons B1 to B6 are distributed across the road 4 in such a manner that the respective communications zones S1 to S6 of the beacons B1 to B6 overlap in pairs and thus cover the entire width L_v of the road 4.

5 It will thus be understood that if a transaction takes place between beacon B1 and a transponder, then that transponder is to be found in the zone S1. If communication takes place between a transponder and two beacons B1 and B2, then the transponder is in the
10 intersection of the zones S1 and S2, i.e. it is in the subzone referenced S1/2 in Figure 2. Consequently, if only one beacon communicates with a transponder, then that transponder is in the portion of the communications zone of the beacon which is not overlapped by a
15 communications zone of an adjacent beacon.

It is therefore possible to subdivide the width L_v of the road 4 into small portions P1, P1/2, ..., P6 each corresponding either to a beacon communications zone that is not overlapped by an adjacent beacon communications
20 zone, or else to a zone of intersection between the communications zones of two adjacent beacons.

In the transponder locating system of the invention, control means U connected to the beacons B1 to B6 acts on the beacons cyclically so as to cause them to transmit
25 signals for establishing communication with a transponder that is about to pass beneath the gantry 1, i.e. which is about to pass through at least one of the communications zones S1 to S6. The control means is organized to detect and identify those beacons which have established
30 communication with the transponder in order to associate the detected beacon(s) with one of the lateral portions P1 to P6 of the road 4.

By way of example, if the beacons B4 and B5 have both established communication with a transponder, then
35 the transponder is situated in the intersection of communications zones S4 and S5, i.e. in the portion P4/5 of the width of the road 4.

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The control means U can be programmed to deliver a signature in the form of a binary word having as many bits as there are laterally defined portions of the road, with a 1 bit in the word indicating the portion in which the transponder is situated, for example.

The control means U is adapted to cause a signal to be transmitted initially by the beacons B1, B3, and B5 and subsequently by the beacons B2, B4, and B6 (or vice versa) so as to avoid problems of interference between adjacent beacons. It should be understood that this time multiplexing of beacon transmissions can be modified.

In addition, the control means U can be adapted to monitor the positioning of a transponder by selectively reactivating the beacon or beacons that have established communication with the transponder by causing them to transmit signals again.

The beacons B can also be used to determine the longitudinal position of a transponder on the road if the control means U is suitable for dating the lateral positioning signatures.

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CLAIMS

1/ A system for locating a transponder (T) travelling along a road (4) of a certain width, the system being characterized in that it comprises:

5 ' a set of beacons (B1 to B6) each suitable for communicating with the transponder (T) if it is located in a communications zone (S) specific to the beacon under consideration and of a width (L_b) that is smaller than the width (L_r) of the road, the beacons being distributed in
10 line across the road so that the communications zones of the beacons (S1 to S6) overlap in pairs and together they cover the entire width of the road; and

 ' control means (U) acting cyclically on the beacons to cause them to transmit signals for establishing
15 communication between themselves and a transponder passing through at least at least one of the beacon communications zones, which control means detect which beacon or beacons have established such communication with the transponder and associate the detected beacon(s)
20 with a certain portion (P1 to P6) of the width of the road indicative of the lateral position of the transponder across the road, said control means (U) activating said beacons (B1 to B6) in a sequence such that two adjacent beacons do not transmit simultaneously.

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2/ A locating system according to claim 1, in which the beacons (B1 to B6) and the transponder (T) communicate at microwave frequencies.

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3/ An installation for remote payment of tolls on a multilane road including a locating system according to claim 1 or 2.

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