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PROTOCOL FOR DETECTING THE PRESENCE OF INDIVIDUALS OR
OBJECTS IN A DEFINED SPACE AND DETECTION SYSTEM
INTENDED TO IMPLEMENT SUCH A PROTOCOL

The present invention concerns a protocol and a system for detecting the presence of individuals or objects, provided with electronic tickets intended for a detection application implementing this protocol, in a defined space having at least one entry. "Entry" also includes an entry-exit or an exit.

5 In particular, the present invention concerns the detection of persons or objects inside means of transport, in particular a train, a metro train or a bus, so as to charge the holders of electronic tickets using these means of transport or to ensure that their journey has been paid for.

10 A first problem for such detection stems from the fact that the individuals enter certain public places or transport means in large numbers at a relatively high speed. A second problem lies in the fact that it is difficult for the space defined particularly by a means of transport to define a closed space inside which an electromagnetic field propagates, without this field also propagating partly outside this defined space. This is particularly true when the doors of the means of transport are open.

15 Then, a low frequency field, in particular of the order of 125 kHz or 13 MHz may be confined in a relatively restricted zone, in particular of oval shape, but the flow of data or instructions able to be transmitted at this frequency is relatively small. Conversely, a relatively high frequency, in particular of the order of 200 MHz or more allows this flow of data or instructions to be greatly increased. However, a system
20 operating with high frequency communication consumes a relatively large amount of power, in particular for electronic tickets in listening mode.

In a defined space having at least one entry, monitoring of the entry and exit of individuals and objects provided with appropriate electronic tickets poses a significant difficulty for individuals or objects coming close to the entry and remaining in proximity
25 thereto. In the case of a bus or a train for example, it may happen that persons provided with such electronic tickets are simply accompanying another person or they may momentarily get into the means of transport to put in someone else's luggage.

Within the scope of means of transport of the train type, particular problems may arise as regards a protocol for detecting the presence of individuals or objects.
30 This is particularly the case when two trains are situated next to each other in a station. It may also happen that these two trains depart simultaneously and thus make part of a journey next to each other. A simple detection protocol in one of the two trains, in particular at a high frequency, effected upon the entry or exit of passengers or even upon the train's departure, can cause malfunctions and interference with

another system arranged in the other train. One could thus have a situation in which a detection system arranged in one train counts the presence of individuals in the other train. One can also envisage that the systems arranged in both trains interfere with each other, which may lead in particular to passengers in one train or the other not
5 being accounted for. It is imperative that all of these situations and others are avoided for a detection protocol for the presence of individuals, particularly for paying the cost of the journey effected with the means of transport used, to be operational with a high level of security.

The present invention proposes to overcome these drawbacks by providing a
10 protocol for detecting the presence of individuals or objects and a system arranged to implement it wherein at least one distance measurement is effected between each electronic ticket entering a monitored defined space and means for measuring said at least one distance. Thus, it is possible to establish with a certain precision whether a person or an object has entered at least in a sub-space of said defined space.

15 However, there remains a major problem for the region of the entry or entries to the defined space when the entry or entries are open. This is essentially due to the precision of the distance measurement effected, this measurement normally being able to be established in a relatively short time interval. Then, the more precise the measuring means need to be, the more significant the increase in the cost thereof.

20 The present invention therefore concerns a protocol for detecting the presence of individuals or objects, provided with electronic tickets intended for a detection application implementing this protocol in a defined spaced having at least one entry, this protocol being characterised in that it includes the following steps when the entry is open:

25 A) awakening all said electronic tickets approaching said entry or passing through said entry and which are not already awakened;

B) implementing process for determining the presence of the awakened electronic tickets in an entry zone, this entry zone being localised at least mostly in immediate proximity to said entry;

30 C) measuring one or more distances between each awakened electronic ticket which leaves said entry zone in the direction of the interior of said defined space and the means for measuring this distance or these distances.

Preferably, awakening during step A is effected at a relatively low frequency, for example 125 kHz. In a preferred embodiment, the entry zone is defined by a first
35 electromagnetic field transmitted by at least a first transmitter, this entry zone being the region where the amplitude of the first electromagnetic field received by the awakened tickets is equal to or greater than a pre-defined minimum value. In an

advantageous variant, awakening of the tickets is also effected by said at least first transmitter.

The localisation of the electronic tickets by the measuring means intervening in step C is effected for example by a distance measuring device formed of several
5 modules arranged spatially at various locations in said defined space. A single monoblock measuring unit may be sufficient in certain cases. Generally, three receiver modules which are not aligned allow proper localisation and reduce the extent of the entry zone to ensure the exact determination of the presence of the tickets in the defined space.

10 In a preferred variant, the awakened electronic tickets do not communicate with the measuring means while the tickets are located in the entry zone and the entry is open. Other variants may also be envisaged.

The detection protocol according to the present invention is preferably completed after the closing of the entry or entries to the defined space by a step in
15 which one or more distances are measured between each electronic ticket which is present in said entry zone inside said defined space and the means for measuring said distance or distances. In a preferred variant, it is provided that the process for determining the presence in said entry zone of said electronic tickets is stopped so that this latter measurement can be effected. In the variant wherein the entry zone is
20 defined by an electromagnetic field, the transmission of this field is stopped so that the electronic tickets present in the part of said entry zone situated inside the defined space no longer receives the field.

It is clear from the latter features of the protocol intervening after closure of the entry or entries, that any electronic ticket intended for the detection application and
25 situated in the defined space is identified in a sure manner, to the exclusion of those which are not in this defined space. This flows in particular from the fact that after the entry or entries are closed, a certain distance separates the individuals or objects inside and outside the defined space. This is all the more so in the case of a means of transport when the latter starts to move. Even in the case of two trains situated next to
30 each other, and departing simultaneously, localisation by at least one distance measurement with a precision of the order of that necessary during step C is more than sufficient to account only for the tickets present inside the defined space being monitored. It will also be noted that the doors closing the entries can form at least partially a shield for the electromagnetic signals used for the distance measurements.

35 One variant provides communication at a relatively high frequency directly after the measurement allowing a ticket to be localised inside the defined space in order to communicate at least one item of data or instruction to the tickets. Another variant,

which is particularly complementary, provides communication after the doors are closed at a relatively high frequency using transmitters supplying an electromagnetic field essentially propagating in the entire defined space with sufficient amplitude in order to ensure communication with all the tickets present in this defined space.

5 Other variants and advantages of the present invention will appear from the following description of an implementation of the protocol according to the invention, given with reference to Figure 1 annexed hereto, given by way of non limiting example. An embodiment of the system for detecting the presence of individuals or objects implementing the detection protocol according to the invention will also be described
10 hereinafter with reference to Figure 1.

Figure 1 shows a carriage 10 of a means of transport having four main entries 2, 3, 4 and 5 and two secondary entries 7 and 8 allowing passage into adjacent carriages. Carriage 10 defines a defined space into which it is possible to enter or leave by means of the main and secondary entries. Each main entry 2 to 5 is fitted
15 with means 12 for detecting individuals provided with electronic tickets 14 intended for the application of detecting the presence of these individuals in carriage 10 or more generally in the means of transport to which this carriage belongs. Secondary entries 7 and 8 may also be fitted with such detection means or other complementary means. However, detection of the movement of individuals through secondary doors 7 and 8 is
20 not a determining factor for monitoring the passengers effecting a certain journey with the means of transport concerned when this means of transport is considered as a whole and is monitored in particular by a centralised system which allows it to be known whether a person who has entered a certain carriage subsequently leaves it via an entry of another carriage.

25 Hereinafter, a detection protocol according to the invention will be described effected at any main entry to carriage 10. The means or devices which are identical to those arranged at the various entries bear the same references.

The flow of people entering or leaving carriage 10 can be relatively high. In the case of the present invention, the individuals entering or leaving carriage 10 in the
30 entry-exit spaces 16 and 18 are detected. This selection differs in particular from detection in the whole of the defined space of carriage 10. In the case of the present invention, it is thus sought to define efficiently and correctly the individuals provided with a ticket 14 who are present at a certain moment in entry-exit spaces 16 and 18.

Two main situations can be defined, one in which main entries 2 to 5 are open
35 and the other in which these main entries are closed.

In the event that the main doors are open, any appropriate electronic ticket 14 carried by a user 12 is awakened, if this is not already the case, upon approaching

entry 5 so that this ticket passes from a listening mode to an active mode. This awakening step allows the necessary power for electronic ticket 14, which is generally an autonomous portable object, to be minimised. This ticket 14 is fitted with means enabling it to determine, once it is awakened, whether it is located in an entry zone 20 positioned at least mostly in immediate proximity to entry 5. Entry zone 20 is defined by an electromagnetic field transmitted by a transmitter 22. More precisely, entry zone 20 is the region where the amplitude of this electromagnetic field received by awakened tickets 14 is equal to or greater than a pre-defined minimum value. According to a first alternative embodiment, the process for determining the presence of a ticket 14 in entry zone 20 consists in this ticket measuring the amplitude of the electromagnetic field transmitted by transmitter 22 to determine whether or not it is less than said minimum value. In another alternative embodiment, transmitter 22 transmits successive signals in zone 20. The awakened tickets receiving these signals with sufficient amplitude to read them are considered to be in zone 20. In this case, the pre-defined minimum value corresponds to the minimum amplitude sufficient for such signals to be received by the tickets.

Preferably, transmitter 22 transmits at a relatively low frequency, for example 125 KHz or approximately 13.5 MHz. In an advantageous variant, the function of awakening tickets 14 is effected using transmitter 22.

According to another variant, ticket 14 is provided to operate like a transponder which responds to an interrogation signal of reader 22. Thus, as long as reader 22 receives a response from ticket 14, the latter is considered to be present in entry zone 22. This latter variant differs from the two others mentioned above in that the data relating to the presence of ticket 14 in zone 20 is in reader 22. This reader is connected to a central electronic unit 30 which then uses this data to implement the detection protocol according to the invention, in particular in order to validate or not validate a distance measurement described hereinafter.

In order to detect the presence of individuals in entry-exit space 16 or 18, there are provided localising means via a measurement of at least one distance. In order to do this, there is provided in the system of Figure 1 a measuring device with three receiver modules 32, 33 and 34 spatially localised at various locations in space 16, respectively 18. Preferably, these three modules are not aligned. In a particular embodiment of the detection system according to the invention, the module or modules of the distance measuring device are arranged so that they receive the electromagnetic signals originating only from inside said defined space and more particularly from entry-exit space 16 or 18 and/or they transmit signals only inside this space. In order to do this, a measuring unit can be arranged in particular above the

entry and shielded at least on its outer side, i.e. on the side oriented towards the exterior relative to a wall containing the entry where the detection is effected so that this measuring unit cannot communicate with the exterior of said defined space in the region of the entry. In this embodiment, the measuring precision is much less critical
5 since the ticket leaving the entry zone which is measured then has to be located inside the defined space, in particular of carriage 10. Thus, a single receiver or transceiver module without great measuring precision can suffice.

Several means known to those skilled in the art for localising a ticket by measuring distance(s) can be used. By way of example, a first variant will be cited
10 wherein the localisation is effected by measuring distance(s) between ticket 14 and the receiver module or modules, the measuring device being arranged to determine a response time for the ticket which returns an echo signal upon receiving at least one signal sent by the measuring device. According to another variant, the distance measurement consists of a measurement by each measuring module of the amplitude
15 of a signal provided by the ticket, either directly, or in response to an excitation signal. One may also provide the opposite case wherein the amplitude measurement is effected by the ticket for a signal received from each measuring module provided.

Each entry zone 20 covers an entry to a defined space. The width of this entry zone 20 is provided so that it is substantially equal to or greater than the inaccuracy
20 over the distance measurement to determine whether ticket 14 is situated inside entry-exit space 16 or 18 and/or to allow communication when electronic tickets pass into this zone. This means that only the tickets 14 which are actually inside carriage 10 are considered as being inside, when the doors are open. As long as the doors are open, the tickets present in the entry zone or zones 20 are not counted as being inside
25 carriage 10. Thus, even with a relatively large uncertainty or error over the distance measurement, the detection of the tickets recorded as having entered the space of carriage 10 is made efficiently and in a reliable manner.

According to the invention, either a ticket 14 situated inside space 16 is localised to the exclusion of entry zones 20, or the distance measurement is validated
30 only when the ticket is situated, during the measurement, outside these zones 20.

In order to separate the tickets present in the entry zone or zones 20 from the counting of the tickets entering or leaving carriage 10, a preferred variant provides that the tickets 14 present in a zone 20 do not communicate with the measuring means while they are situated in this zone and the corresponding entry is open. In another
35 variant, it is possible also to localise the tickets situated in entry zones 20, but to validate a measurement, when the entries are open, only if the ticket measured was then outside a zone 20. The data which allows one to know whether the ticket is in

zone 20 during a distance measurement can be achieved either by the ticket itself sending a data signal to a receiver or reader provided in the system according to the present invention, or by a reader and in particular reader 22 in the case wherein this determination is effected at such a reader as mentioned previously with reference to a
5 variant.

In a preferred variant, communication is effected either at a high frequency, or a low frequency with reader 22 when the tickets are in entry zone 20. This communication is used for the identification of the tickets. The detection system arranged in carriage 10, in particular central unit 30, can then establish a list of all the
10 tickets entering a given zone 20. From this moment, the system knows that a distance measurement has to be effected for all these tickets when they enter further inside carriage 10 or, as appropriate, when they leave by another entry. After the doors have closed, the remainder of the tickets is also preferably detected by a measurement determining whether they are situated inside carriage 10. However, when dealing with
15 a means of transport which starts to move, the candidates remaining on the list should usually be situated inside carriage 10 given that those who were outside the carriage and yet inside an entry zone 20, generally leave such zone when the means of transport starts to move.

It will be noted that other instructions or data can be exchanged when the
20 tickets are present in entry zones 20. According to a particular implementation, communication at a relatively high frequency is provided with a transmitter 41 or 42 respectively covering entry-exit zones 16 and 18. During this communication, at least one item of data or instruction is supplied to the entering ticket. If this has not already been done in zone 20, it is possible to communicate to the ticket the carriage in which
25 it is situated and the station in which it got into the carriage. An instruction resetting the tickets into listening mode may be provided at this moment. It is also possible to provide that the tickets are again in an active mode after a certain determined time interval which is communicated to them.

It will be noted that, preferably, the listening mode is provided at a relatively low
30 frequency, which means that the ticket cannot be awakened using a relatively high frequency transmitter. In a particular embodiment of the detection system according to the invention, one or more relatively high frequency transmitters and/or receivers 44 are arranged in the defined space of carriage 10 so as to cover by the electromagnetic field transmitted at a relatively high frequency the entire defined space with a view of
35 communicating with all the tickets present inside this space. It will be noted that the range of the field transmitted at a high frequency may generally extend outside the limits of carriage 10. However, as a result of the invention the system knows the list of

tickets present inside so that valid communication will only be established with those particular tickets.

Once the entries are closed, the protocol according to the invention is advantageously completed by a step in which the tickets remaining in entry zones 20
5 are counted by distance measuring units 32 to 34. It will be noted that the situation with the entries closed differs from that with the entries open in that usually at least the persons situated outside the carriage should move away from these entries. Thus, even if the distance measurement has a not negligible inaccuracy, only those persons present in entry zone 20 inside the space of carriage 10 will be detected. In other
10 words, a maximum distance below which a ticket is considered to be inside the carriage can be increased when the doors are closed, and this is all the more so in the case of a means of transport which starts to move. Thus, taking account of possible measurement errors, a measuring result corresponding to a point situated just outside carriage 10 will be considered as being inside the carriage. Thus, an electronic ticket is
15 considered to be inside said defined space if the result of the measurement is situated in a given range or zone of values.

The measurement after the doors have closed is preferably effected immediately after a halt in the previously described process for determining the presence of tickets in an entry zone. In particular, the transmission of an
20 electromagnetic field by transmitters 22 is ended. According to other variants, the tickets 14 present in the entry zone then receive an instruction to communicate with the measuring means. Other variants may be envisaged by those skilled in the art.

Finally, it will be noted that the various transmitters or readers are advantageously connected to a central unit 30 for centralised control of the various
25 data. When several carriages are linked, in particular to form a train, a unit for supervising all the carriages can advantageously be provided, in particular when the passages from one carriage to another are not fitted with detection means for example according to the present invention.



CLAIMS

1. Protocol for detecting the presence of individuals or objects, provided with electronic tickets (14) intended for a detection application implementing this protocol, in a defined spaced (10) having at least one entry (2, 3, 4, 5), characterised in that it includes the following steps when the entry is open:

- 5 A) awakening all said electronic tickets approaching said entry or passing through said entry and which are not already awakened;
- B) implementing process for determining the presence of the awakened electronic tickets in an entry zone (20), this entry zone being localised at least mostly in immediate proximity to said entry;
- 10 C) measuring one or more distances between each awakened electronic ticket which leaves said entry zone towards the interior of said defined space and the means (32, 33, 34) for measuring at least one distance.

2. Protocol according to claim 1, characterised in that said awakening during step A is effected at a relatively low frequency, for example 125 kHz or
15 approximately 13.5 MHz.

3. Protocol according to claim 1 or 2, characterised in that said entry zone is defined by a first electromagnetic field transmitted by at least a first transmitter (22), this entry zone being the region where the amplitude of this first electromagnetic field received by said awakened tickets is equal to or greater than a minimum reception
20 value by said tickets.

4. Protocol according to claim 3, characterised in that said at least first transmitter transmits at a relatively low frequency, for example 125 KHz or approximately 13.5 MHz.

5. Protocol according to claim 3 or 4, characterised in that said process for
25 determining the presence in said entry zone of the awakened electronic tickets consists in these tickets measuring the amplitude of said first electromagnetic field to determine whether or not it is less than said minimum value.

6. Protocol according to claim 3 or 4, characterised in that said process for determining the presence in an entry zone of the awakened electronic tickets consists
30 in said at least first transmitter (22) sends signals into said entry zone, the awakened tickets which receive these signals with sufficient amplitude to read them being considered as being in said entry zone, this amplitude being sufficient if it is equal to or greater than said minimum value.

7. Protocol according to any of the preceding claims, characterised in that
35 said means for measuring said at least one distance are formed by a device having



several measuring modules (32, 33, 34) spatially localised at various locations in said defined space (10).

8. Protocol according to any of the preceding claims, characterised in that said measurement of said at least one distance is effected by a measurement of the response time of each ticket leaving said entry zone which sends an echo signal upon receiving a signal sent by said measuring means.

9. Protocol according to any of claims 1 to 7, characterised in that said measurement of at least one distance between each ticket leaving said entry zone and said measuring means consist in a measurement by said measuring means of the amplitude of a signal provided by this ticket.

10. Protocol according to any of the preceding claims characterised in that said awakened electronic tickets do not communicate with said measuring means while they are situated in said entry zone and while said entry is open.

11. Protocol according to any of claims 1 to 9, characterised in that said awakened tickets situated in said entry zone communicate with said measuring means, any measurement of at least one distance between a ticket and said measuring means being validated, when said entry is open, only if the ticket was then outside said entry zone.

12. Protocol according to any of the preceding claims, characterised in that said awakened electronic tickets give their identification in said entry zone, a list of all the identified tickets being established.

13. Protocol according to any of the preceding claims, characterised in that as soon as an electronic ticket is detected inside said defined space, a relatively high frequency communication is established with a second transmitter (41, 42) which provides it with at least one item of data or instruction.

14. Protocol according to any of the preceding claims, characterised in that said steps A to C are followed by the following step after said entry has closed:

D) measuring at least one distance between each electronic ticket which is present in said entry zone inside said defined space and the means for measuring this at least one distance, this electronic ticket being considered as being inside said defined space if the result of this measurement is situated in a given range or zone of values.

15. Protocol according to claim 14, characterised in that said measurement of step D is effected immediately after a halt in said process for determining the presence of said electronic tickets in said entry zone.



16. Protocol according to claims 14 and 10, characterised in that said tickets present in said entry zone receive an instruction to communicate, after said entry has closed, with said measuring means intervening in said step D.

17. Protocol according to claims 14 and 11, characterised in that said
5 measurement of at least one distance provided in step C is validated after said entry has closed, when said at least one distance is situated in said pre-defined range of values.

18. Protocol according to any of the preceding claims, characterised in that
10 after said entry has closed, a communication is established between the tickets detected inside said defined space and communication means (41, 42, 44) which transmit an electromagnetic field at a relatively high frequency, this electromagnetic field propagating in the whole of said defined space with sufficient amplitude to assure communication with all the tickets.

19. Protocol according to any of claims 14 to 18 wherein said defined space
15 is defined by a means of transport, characterised in that said step D only occurs once the means of transport starts to move after said entry has closed.

20. System for detecting the presence of individuals or objects provided with
20 electronic tickets and intended for a detection application implementing a detection protocol according to any of the preceding claims, in a defined space having at least one entry, characterised in that it includes:

- first means (22) for awakening all of said electronic tickets approaching said entry or passing through said entry and which are not already awakened;

- second means (22) for determining the presence in an entry zone of the
25 awakened electronic tickets, this entry zone being localised at least mostly in immediate proximity to said entry;

- third means (32, 33, 34) for measuring at least one distance between each
awakened electronic ticket which leaves said entry zone towards said defined space and means for measuring said at least one distance, these third measuring means being arranged so that this measurement is effected with sufficient precision to
30 determine whether the ticket is situated inside said defined space.

21. System according to claim 20, characterised in that said first means operate at a relatively low frequency, for example 125 KHz or approximately 13.5 MHz.

22. System according to claim 20 or 21, characterised in that said second
35 means include at least a first transmitter (22) providing a first electromagnetic field with a predetermined power in said entry zone.



23. System according to claim 22, characterised in that said at least first transmitter operates at a relatively low frequency, for example 125 KHz or approximately 13.5 MHz.

24. System according to claim 22 or 23, characterised in that said first means
5 are also formed by said at least first transmitter.

25. System according to any of claims 20 to 24, characterised in that said third means are formed by a device having several measuring modules (32, 33, 34) localised spatially at different locations in said defined space.

26. System according to any of claims 20 to 25, characterised in that said
10 third measuring means are arranged above said entry with an electromagnetic shield on the side of the wall containing the entry so that said measuring means cannot communicate with the exterior of said defined space in the region of said entry.

27. System according to any of claims 20 to 26, characterised in that it
15 includes at least also a second transmitter (41, 42) operating at a relatively high frequency and being used to provide at least one item of data or an instruction to the awakened electronic tickets as soon as they are detected inside said defined space.

28. System according to any of claims 20 to 27, characterised in that it
20 includes communication means (41, 42, 44) which transmit an electromagnetic field at a relatively high frequency, this field propagating in the whole of said defined space with sufficient amplitude to assure communication with all the tickets detected inside said defined space.

29. System according to any of claims 20 to 28, characterised in that said second and third means are connected to a central control unit (30) which establishes a list of the tickets having entered said entry zone.

25 30. System according to any of claims 20 to 29, wherein said defined space has several entries, characterised in that each entry is fitted with said first, second and third means.