

SYSTEM AND METHOD OF TRACKING OBJECTS

TECHNICAL FIELD

[0001] Various embodiments relate generally to a system and a method of tracking
5 objects in a space area.

BACKGROUND

[0002] Passive radio frequency identification (RFID) tags and active RFID tags are generally used to track items or objects. Passive RFID tags, which are battery-less, can
10 only be turned on when they are within a reading range of a RFID reader. Thus, the read range of passive RFID tags is limited, and is thus not suitable for real-time tracking of items of objects. However, passive RFID technology is preferred due to its low cost.

[0003] On the other hand, active RFID tags have on-board battery. Thus, active RFID tags are always on and have a longer tracking distance. As such, active RFID tags can be
15 used for real-time tracking of items or objects. However, using active RFID tags for large-scale item level tracking of items or objects would incur higher costs as compared to using passive RFID tags. Furthermore, it may also be feasible to use active RFID tags in some applications. For example, it is not safe to use active RFID tags for carrying on board aircraft in aviation logistics application.

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SUMMARY

[0004] According to one embodiment, a system for tracking objects in a space area is provided. The system may include a plurality of passive radio frequency identification

(RFID) tags, each passive RFID tag being disposed on an object; a plurality of active RFID tags, each active RFID tag being disposed at one of a plurality of checkpoints or on one of a plurality of mobile handling equipments in the space area; a plurality of passive RFID readers, each passive RFID reader being disposed at a respective checkpoint or on
5 a respective mobile handling equipment and being configured to communicate with one or more detected passive RFID tags; a plurality of controllers, each controller being disposed at a respective checkpoint or on a respective mobile handling equipment and being configured to communicate with the corresponding passive RFID reader disposed at the checkpoint or on the mobile handling equipment; a plurality of active RFID
10 readers, each active RFID reader being associated with one of a plurality of predefined zones of the space area and being configured to communicate with the active RFID tags of one or more checkpoints and/or the active RFID tags of one or more mobile handling equipments located in the associated predefined zone.

[0005] According to another embodiment, a method of tracking objects in a space
15 area is provided. The method may include using a plurality of passive radio frequency identification (RFID) tags, and disposing each passive RFID tag on an object; using a plurality of active RFID tags, and disposing each active RFID tag at one of a plurality of checkpoints or on one of a plurality of mobile handling equipments in the space area; using a plurality of passive RFID readers, and disposing each passive RFID reader at a
20 respective checkpoint or on a respective mobile handling equipment such that each RFID communicates with one or more detected passive RFID tags; using a plurality of controllers, and disposing each controller at a respective checkpoint or on a respective mobile handling equipment such that each controller communicates with the

corresponding passive RFID reader disposed at the checkpoint or on the mobile handling equipment; and using a plurality of active RFID readers such that each active RFID reader is associated with one of a plurality of predefined zones of the space area and communicates with the active RFID tags of one or more checkpoints and/or the active
5 RFID tags of one or more mobile handling equipments located in the associated predefined zone.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] In the drawings, like reference characters generally refer to the same parts
10 throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments of the invention are described with reference to the following drawings, in which:

[0007] Figure 1 shows a schematic diagram of a system for tracking objects
15 according to one embodiment of the present invention.

[0008] Figure 2 shows a schematic diagram of data flow of a system for tracking objects according to one embodiment of the present invention.

[0009] Figure 3 shows a schematic diagram of a processor usable in a system for tracking objects according to one embodiment of the present invention.

20 [0010] Figure 4 shows a schematic diagram of a system for tracking objects implemented in an aviation logistics environment according to one embodiment of the present invention.

[0011] Figure 5 shows a flowchart of a method of tracking objects according to one embodiment of the present invention.

DETAILED DESCRIPTION

5 [0012] Embodiments of a system and a method of tracking objects will be described in detail below with reference to the accompanying figures. It will be appreciated that the embodiments described below can be modified in various aspects without changing the essence of the invention.

[0013] Figure 1 shows a schematic drawing of a system 100 for tracking objects. The
10 system 100 may include a plurality of passive radio frequency identification (RFID) tags 102, a plurality of active RFID tags 104, a plurality of passive RFID readers 106, a plurality of active RFID readers 108, and a plurality of controllers 110. The system may also include a processor 112 and a location determiner 114, e.g. implemented as a location determining circuit.

15 [0014] In various embodiments, a "circuit" may be a programmable processor such as e.g. a microprocessor (e.g. a Complex Instruction Set Computer (CISC) processor or a Reduced Instruction Set Computer (RISC) processor).

[0015] In various embodiments, a "circuit" may be understood as any kind of a logic implementing entity, which may be special purpose circuitry or a processor executing
20 software stored in a memory, firmware, or any combination thereof. Thus, in an embodiment, a "circuit" may be a hard-wired logic circuit or a programmable logic circuit such as a programmable processor, e.g. a microprocessor (e.g. a Complex Instruction Set Computer (CISC) processor or a Reduced Instruction Set Computer

(RISC) processor). A "circuit" may also be a processor executing software, e.g. any kind of computer program, e.g. a computer program using a virtual machine code such as e.g. Java. Any other kind of implementation of the respective functions which will be described in more detail below may also be understood as a "circuit" in accordance with
5 an alternative embodiment.

[0016] The system 100 may be implemented in various environments. Some environments in accordance with various embodiments are industrial shop floor environment and aviation logistics environment. Figure 1 shows the system 100 being implemented into a shop environment 120. The shop environment 120 may have a
10 plurality of objects 122, a plurality of mobile handling equipments 124 and a plurality of checkpoints 126. The objects 122 may be boxes of items or individual items. The mobile handling equipments 124 may be forklifts and trolleys. The checkpoints 126 may be storage shelves. Further, the space area of the shop environment 120 may be divided into a plurality of predefined zones 128.

15 [0017] Each passive RFID tag 102 may be disposed on a respective object 122. The passive RFID tags 102 may be used to identify the respective objects 122. Each active RFID tag 104 may be disposed either on one of a plurality of mobile handling equipments 124 or at one of a plurality of checkpoints 126. The active RFID tags 104 may be used to identify the respective mobile handling equipments 124 or the respective
20 checkpoints 126.

[0018] Each passive RFID reader 106 may be disposed on a respective mobile handling equipment 124 or at a respective checkpoint 126. In one embodiment, the passive RFID readers 106 may be fixed to the mobile handling equipments 124 and at the

checkpoints 126. In various embodiments, the passive RFID readers 106 may be handheld readers. Each controller 110 may be disposed on a respective mobile handling equipment 124 or at a respective checkpoint 126. Each controller 110 may be configured to communicate with the corresponding passive RFID reader 106 disposed at the same
5 checkpoint 126 or on the same mobile handling equipment 124.

[0019] Each active RFID reader 108 may be associated with one of the plurality of predefined zones 128 of the space area. Each active RFID reader 108 may be configured to communicate with the active RFID tags 104 of one or more checkpoints 126 and/or the active RFID tags 104 of one or more mobile handling equipments 124 located in the
10 associated predefined zone 128. In one embodiment, the positions of the active RFID readers 108 may be the same in the associated predefined zones 128. For example, the active RFID readers 108 may be positioned in the centre of the associated predefined zones 128. In various embodiments, the positions of the active RFID readers 108 may be different in the associated predefined zones 128.

15 [0020] When the objects 122 are moved by hand, the objects 122 may be tracked by the passive readers 106 disposed at the checkpoints 126. When the objects 122 are moved by the mobile handling equipments 124, the objects 122 on the mobile handling equipments 124 may be tracked by the passive readers 106 disposed on those mobile handling equipments 124.

20 [0021] In more detail, each passive RFID reader 106 may communicate with the passive RFID tags 102 detected within its reading range. For example, a passive RFID reader 106 on a mobile handling equipment 124 or at a checkpoint 126 may communicate with the passive RFID tags 102 of the objects 122 disposed on or near the mobile

handling equipment 124 or the checkpoint 126. A signal may be sent from each detected passive RFID tag 102 to the passive RFID reader 106. A signal from each detected passive RFID tag 102 to the passive RFID reader 106 may include information indicative of an identification number of the associated object 122. In various embodiments, the signal may include additional information such as e.g. strength of signal, a time when the signal is sent from the passive RFID tag 102 and a time when the signal is received by the passive RFID reader 106. Each passive RFID reader 106 may then send a signal to the corresponding controller 110. A signal from each passive RFID reader 106 to the corresponding controller 110 may include information indicative of the identification numbers of the objects 122 and an identification number of the mobile handling equipment 124 or the checkpoint 126. In other embodiments, the signal may include additional information such as e.g. strength of signal, a time when the signal is sent from the passive RFID reader 106, and a time when the signal is received by the controller 110.

[0022] The mobile handling equipments 124 and the checkpoints 126 are tracked by the respective active RFID tags 104 communicating with the active RFID readers 108 in the respective zones 128. That is, the active RFID tags 104 of the mobile handling equipments 124 and the checkpoints 126 located in one zone 128 may communicate with the active RFID reader 108 of the same zone 128. A signal from each active RFID tag 104 to the corresponding active RFID reader 108 may include information indicative of an identification number of the checkpoint 126 or the mobile handling equipment 124. In other embodiments, the signal may include additional information.

[0023] The processor 112 of the system 100 may receive signals from the plurality of controllers 110 and the plurality of active RFID readers 108. The plurality of controllers 110 and the plurality of active RFID readers 108 may send signals to the processor 112 continuously. The signal from each controller 110 to the processor 112 may include
5 information indicative of the identification numbers of the objects 122, the identification number of the checkpoint 126 or the mobile handling equipment 124, strength of the signal, and a time when the signal is sent from the controller 110. The signal from each active RFID reader 108 to the processor 112 may include information indicative of the identification number of the checkpoint 126 or the mobile handling equipment 124,
10 strength of the signal, and a time when the signal is sent from the active RFID reader 108. In other embodiments, the signals may include additional information such as e.g. a time when the signal is received by the processor 112.

[0024] The location determiner 114 of the system may determine locations of the checkpoints 126 and locations of the mobile handling equipments 124 based on
15 information indicative of the identification numbers of the checkpoints 126, the identification numbers of the mobile handling equipments 124, and the strength of the signals sent from the active RFID readers 108. In one embodiment, the location determiner 114 may receive the information from the processor 112. In another embodiment, the location determiner 114 may receive the information from the active
20 RFID readers 108. In one embodiment, the location determiner 114 may be a real-time location system (RTLS). The location determiner 114 may determine the locations of the checkpoints 126 and the locations of the mobile handling equipments 124 based on a triangular-based localization approach.

[0025] The location determiner 114 may be configured to transmit a signal indicative of the locations of the checkpoints 126, the corresponding identification numbers of the checkpoints 126, the locations of the mobile handling equipments 124, and the corresponding identification numbers of the mobile handling equipments 124 to the processor 112. In other embodiments, the signal may include additional information such as e.g. strength of the signal, a time when the signal is sent from the location determiner 114, and a time when the signal is received by the processor 112.

[0026] Figure 2 shows a schematic diagram of an exemplary data flow of the system 100. A signal 202 including information indicative of the identification numbers of the objects 122 (Inventory ID), the identification number of the mobile handling equipment 124 (Source ID), and a time when the signal is sent (Timestamp) may be sent from the mobile handling equipment 124 to the processor 112. A signal 204 including information indicative of the identification numbers of the objects 122 (Inventory ID), the identification number of the checkpoint 126 (Source ID), and a time when the signal is sent (Timestamp) may be sent from the checkpoint 126 to the processor 112. In one embodiment, the signals 202, 204 may be sent respectively from the controller 110 of the mobile handling equipment 124 and the controller 110 of the checkpoint 126 to the processor 112.

[0027] Further, a signal 206 including information indicative of the identification number of the mobile handling equipment 124 (Source ID) and strength of the signal (RSSI – received signal strength indication) may be sent from the mobile handling equipment 124 to the location determiner 114. A signal 208 including information

indicative of the identification number of the checkpoint 126 (Source ID) and strength of the signal (RSSI) may be sent from the checkpoint 126 to the location determiner 114.

[0028] In one embodiment, the signals 206, 208 may be sent respectively from the controller 110 of the mobile handling equipment 124 and the controller 110 of the checkpoint 126 to the location determiner 114. In another embodiment, the signals 206, 208 may be sent respectively from the active RFID tag 104 of the mobile handling equipment 124 and the active RFID tag 104 of the checkpoint 126 to the respective active RFID readers 108 and then from the active RFID readers 108 to the location determiner 114. In yet another embodiment, the signals 206, 208 may be sent in both manners.

10 [0029] A signal 210 including information indicative of the identification numbers of the mobile handling equipments 124 and the checkpoints 126 (Source ID) and the locations of the mobile handling equipments 124 and the checkpoints 126 (Grid Location) may be sent from the location determiner 114 to the processor 112.

[0030] Figure 3 shows a schematic diagram of the processor 112. The processor 112 may include a first database 302 for storing information indicative of any one of a group consisting of the identification numbers of the objects 122, the identification numbers of the checkpoints 126, the identification numbers of the mobile handling equipments 124, and the time when the signals are sent from the controllers 110. The processor 112 may also include a second database 304 for storing information indicative of the locations of the checkpoints 126, the corresponding identification numbers of the checkpoints 126, the locations of the mobile handling equipments 124, the corresponding identification numbers of the mobile handling equipments 124, and a time when the signal is sent from the location determiner 114.

[0031] The processor 112 may update the information stored in the first database 302 every time a signal is received from one or more controllers 110. The processor 112 may update the information stored in the second database 304 every time a signal is received from the location determiner 114.

5 [0032] At the time of updating the information stored in the first database 302, the processor 112 may also determine the locations of the objects 122 based on an algorithm which is based on finding the best matching timestamp within a configurable time window for an identification number of a mobile handling equipment 124 or a checkpoint 126, and may store information indicative of the locations of the objects 122. In other
10 words, the processor 112 may determine the identification number of the mobile handling equipment 124 or checkpoint 126 based on received information indicative of the identification of an object 122 and a time when a signal is sent from a controller 110. The processor 112 may then select the location of the mobile handling equipment 124 or checkpoint 126 from the second database 304 based on the corresponding identification
15 number of the mobile handling equipment 124 or checkpoint 126 and the best match of the time the signal is sent from the controller 110. The processor 112 may store information indicative of the location of the object 122 in the first database 302.

[0033] Further as shown in Figure 3, the system 100 may include a user interface 306 coupled to the processor 112. The user interface 306 may be configured to allow users to
20 query locations of one or more objects 122. The user interface 306 may be or include a computer which allows users to query the locations of the objects 122 via a web browser. The location of the object 122 stored in the processor 112 may be displayed on a display screen of the user interface 306.

[0034] Figure 4 shows a schematic diagram of the system 100 implemented in an aviation logistics environment 400. In this embodiment, a space area of the aviation logistics environment 400 may be divided into a plurality of zones 402. The zones 402 may include the warehouse, the receiving area, the storage area and the build up area. The objects 404 may be pallets and cartons. The mobile handling equipments 406 may be forklifts for transporting the pallets and the cartons 404. The checkpoints 408 may be respective exit points or gantries of the zones 402.

[0035] Passive RFID tags (not shown) may be disposed on the pallets and the cartons 404. Active RFID tags (not shown), passive RFID readers 106 and controllers (not shown) may be disposed on the respective mobile handling equipments 406 or at the respective checkpoints 408. The passive RFID readers 106 disposed at the checkpoints 408 may be handheld readers. Active RFID readers (not shown) may be disposed at the respective zones 402.

[0036] The passive RFID tags disposed on the pallets and the cartons 404 may be scanned by the passive RFID readers 106 of the mobile handling equipments 406 and the checkpoints 408 before leaving the various zones 402. In short, the passive RFID readers 106 of the mobile handling equipments 406 and the checkpoints 408 in one zone 402 communicate with the passive RFID tags disposed on the pallets and the cartons 404 in the same zone 402. The passive RFID readers 106 may respectively communicate with a corresponding controller disposed on the same mobile handling equipment 406 or at the same checkpoint 408.

[0037] The active RFID tags of the mobile handling equipments 406 and the checkpoints 408 may communicate with the respective active RFID readers disposed at the same zone 402.

[0038] The locations of the mobile handling equipments 406 and the checkpoints 408

5 may be determined by a location determiner (not shown), which may be implemented by a location determining circuit. Signals 420a, 420b, 420c, 420d including information indicative of identification numbers of the pallets and the cartons 404, identification number of the mobile handling equipment 406 or the checkpoint 408, and a time when the signal is sent may be respectively sent from the controllers 416 of the mobile
10 handling equipments 406 and the controllers 416 of the checkpoints 408 to a RFID server or a processor 422. Signals including information indicative of identification numbers of the pallets and the cartons 404, identification number of the mobile handling equipment 406 or the checkpoint 408, and a time when the signal is sent may also be sent from the active RFID readers to the RFID server or the processor 422.

15 [0039] A signal 424 may be sent from e.g. the passive RFID reader 106 or from the controller of one mobile handling equipment 406 or checkpoint 408 to the RFID server or the processor 422 to track the location or to query the status of the pallets and the cartons 404. A signal 426 including information indicative of the location or the status of the pallets and the cartons 404 may be sent from the RFID server or the processor 422 to the
20 passive RFID reader 106 or the controller.

[0040] Figure 5 shows a flowchart 500 of a method of tracking objects in e.g. a space area. At 502, a plurality of passive radio frequency identification (RFID) tags may be used, and each passive RFID tag may be disposed on an object. At 504, a plurality of

active RFID tags may be used, and each active RFID tag may be disposed at one of a plurality of checkpoints or on one of a plurality of mobile handling equipments in the space area. At 506, a plurality of passive RFID readers may be used, and each passive RFID reader may be disposed at a respective checkpoint or on a respective mobile
5 handling equipment such that each RFID communicates with one or more detected passive RFID tags. At 508, a plurality of controllers may be used, and each controller may be disposed at a respective checkpoint or on a respective mobile handling equipment such that each controller communicates with the corresponding passive RFID reader disposed at the checkpoint or on the mobile handling equipment. At 510, a plurality of
10 active RFID readers may be used such that each active RFID reader is associated with one of a plurality of predefined zones of the space area and communicates with the active RFID tags of one or more checkpoints and/or the active RFID tags of one or more mobile handling equipments located in the associated predefined zone.

[0041] The above described system and method integrate both passive and active
15 RFID technologies to track objects in a space area. Thus, the above described system may be termed as a heterogeneous RFID network system (HERNET). The above described system and method can provide a real-time continuous tracking of the passive RFID tags (i.e. objects) using both the passive and active RFID technologies. The above described system and method can provide an active RFID tracking of location and a passive RFID
20 tracking of inventory.

[0042] The above described system and method can use a high volume lower cost consumable passive tagging of inventory items for identification; a low volume higher cost reusable active tagging of mobile handling equipments and checkpoints for

localization, and loosely coupled synchronization of identification and localization. The above described system and method can provide a higher time accuracy of location tracking of objects when the object is moved by a mobile handling equipment as compared to when the object is not moved by a mobile handling equipment (e.g. by hand).

[0043] As real-time operational visibility on e.g. a shop floor is becoming more important for manufacturers, retailers and logistic providers to increase efficiency and optimize business processes, the above described system and method which have tracking capability can help in reducing costs, delays, cycle times and waste, and in increasing throughput. The above described system and method can provide real-time visibility in business operations. The above described system and method can provide low cost large-scale real-time tracking of inventory items on e.g. a shop floor.

[0044] While embodiments of the invention have been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

CLAIMS

What is claimed is:

- 5 1. A system for tracking objects in a space area, the system comprising:
- a plurality of passive radio frequency identification (RFID) tags, each passive
RFID tag being disposed on an object;
- a plurality of active RFID tags, each active RFID tag being disposed at one of a
plurality of checkpoints or on one of a plurality of mobile handling equipments in the
10 space area;
- a plurality of passive RFID readers, each passive RFID reader being disposed at a
respective checkpoint or on a respective mobile handling equipment and being
configured to communicate with one or more detected passive RFID tags;
- a plurality of controllers, each controller being disposed at a respective checkpoint
15 or on a respective mobile handling equipment and being configured to communicate with
the corresponding passive RFID reader disposed at the checkpoint or on the mobile
handling equipment;
- a plurality of active RFID readers, each active RFID reader being associated with
one of a plurality of predefined zones of the space area and being configured to
20 communicate with the active RFID tags of one or more checkpoints and/or the active
RFID tags of one or more mobile handling equipments located in the associated
predefined zone.

2. The system of claim 1,
wherein a signal sent to the passive RFID reader from each detected passive RFID tag comprises information indicative of an identification number of the object.

3. The system of claim 2,
wherein a signal from each passive RFID reader to the corresponding controller comprises information indicative of the identification numbers of the objects and an identification number of the checkpoint or the mobile handling equipment.

4. The system of claim 1,
wherein a signal from each active RFID tag to the corresponding active RFID reader comprises information indicative of an identification number of the checkpoint or the mobile handling equipment.

5. The system of any one of claims 1 to 4, further comprising:
a processor configured to receive signals from the plurality of controllers and the plurality of active RFID readers.

6. The system of claim 5,
wherein the signal from each controller to the processor comprises information indicative of any one of a group consisting of the identification numbers of the objects, the identification number of the checkpoint or the mobile handling equipment, strength of the signal, and a time when the signal is sent from the controller.

7. The system of claim 5,

wherein the signal from each active RFID reader to the processor comprises information indicative of any one of a group consisting of the identification number of the checkpoint or the mobile handling equipment, strength of the signal, and a time when the signal is sent from the active RFID reader.

8. The system of claim 7, further comprising:

a location determiner configured to determine locations of the checkpoints and locations of the mobile handling equipments based on information indicative of the identification numbers of the checkpoints, the identification numbers of the mobile handling equipments, and the strength of the signals sent from the active RFID readers.

9. The system of claim 8,

wherein the location determiner is configured to receive the information from the processor.

10. The system of claim 8,

wherein the location determiner is configured to receive the information from the active RFID readers.

11. The system of any one of claims 8 to 10,

wherein the location determiner is configured to transmit a signal indicative of the locations of the checkpoints, the corresponding identification numbers of the checkpoints, the locations of the mobile handling equipments, and the corresponding identification numbers of the mobile handling equipments to the processor.

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12. The system of claim 11,

wherein the processor comprises:

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a first database for storing information indicative of any one of a group consisting of the identification numbers of the objects, the identification numbers of the checkpoints, the identification numbers of the mobile handling equipments, and the time when the signals are sent from the controllers; and

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a second database for storing information indicative of the locations of the checkpoints, the corresponding identification numbers of the checkpoints, the locations of the mobile handling equipments, the corresponding identification numbers of the mobile handling equipments to the processor, and a time when the signal is sent from the location determiner.

13. The system of claim 12,

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wherein the processor is configured to update the information stored in the first database every time a signal is received from one or more controllers.

14. The system of claim 12,

wherein the processor is configured to update the information stored in the second database every time a signal is received from the location determiner.

15. The system of any one of claims 5 to 14, further comprising:

5 a user interface coupled to the processor,

wherein the user interface is configured to allow users to query locations of one or more objects.

16. The system of claim 15,

10 wherein the processor is configured to determine the locations of the one or more objects based on the locations of the checkpoints and the mobile handling equipments.

17. A method of tracking objects in a space area, the method comprising:

using a plurality of passive radio frequency identification (RFID) tags, and

15 disposing each passive RFID tag on an object;

using a plurality of active RFID tags, and disposing each active RFID tag at one of a plurality of checkpoints or on one of a plurality of mobile handling equipments in the space area;

20 using a plurality of passive RFID readers, and disposing each passive RFID reader at a respective checkpoint or on a respective mobile handling equipment such that each RFID communicates with one or more detected passive RFID tags;

using a plurality of controllers, and disposing each controller at a respective checkpoint or on a respective mobile handling equipment such that each controller

communicates with the corresponding passive RFID reader disposed at the checkpoint or on the mobile handling equipment;

using a plurality of active RFID readers such that each active RFID reader is associated with one of a plurality of predefined zones of the space area and communicates with the active RFID tags of one or more checkpoints and/or the active RFID tags of one or more mobile handling equipments located in the associated predefined zone.

18. The method of claim 17, further comprising:

transmitting a signal comprising information indicative of an identification number of the associated object from each detected passive RFID tag to the passive RFID reader.

19. The method of claim 18, further comprising:

transmitting a signal comprising information indicative of the identification numbers of the objects and an identification number of the checkpoint or the mobile handling equipment from each passive RFID reader to the corresponding controller.

20. The system of claim 17, further comprising:

transmitting a signal comprising information indicative of an identification number of the associated checkpoint or the associated mobile handling equipment from each active RFID tag to the corresponding active RFID reader.

21. The method of any one of claims 17 to 20, further comprising:
receiving signals from the plurality of controllers and the plurality of active RFID readers via a processor.

5 22. The method of claim 21,
wherein the signal from each controller to the processor comprises information indicative of any one of a group consisting of the identification numbers of the objects, the identification number of the checkpoint or the mobile handling equipment, strength of the signal, and a time when the signal is sent from the controller.

10 23. The method of claim 21,
wherein the signal from the active RFID reader to the processor comprises information indicative of any one of a group consisting of the identification number of the checkpoint or the mobile handling equipment, strength of the signal, and a time when
15 the signal is sent from the active RFID reader.

24. The method of claim 23, further comprising:
determining locations of the checkpoints and locations of the mobile handling equipments via a location determiner based on information indicative of the identification
20 numbers of the checkpoints, the identification numbers of the mobile handling equipments, and the strength of the signals received from the active RFID readers.

25. The method of claim 24,

wherein the information is received from the processor.

26. The method of claim 24,
wherein the information is received from the active RFID readers.

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27. The method of any one of claims 24 to 26, further comprising:
transmitting to the processor a signal indicative of the locations of the
checkpoints, the corresponding identification numbers of the checkpoints, the locations of
the checkpoints the mobile handling equipments, and the corresponding identification
10 numbers of the mobile handling equipments.

28. The method of claim 27, further comprising:
storing in a first database information indicative of any one of a group consisting
of the identification numbers of the objects, the identification numbers of the
15 checkpoints, the identification numbers of the mobile handling equipments, and the time
when the signals are sent from the controllers and the mobile handling equipments; and

- storing in a second database information indicative of the locations of the
checkpoints, the corresponding identification numbers of the checkpoints, the locations of
the checkpoints the mobile handling equipments, the corresponding identification
20 numbers of the mobile handling equipments, and a time when the signal is sent from the
location determiner.

29. The method of claim 28, further comprising:

updating the information stored in the first database every time a signal is received from one or more controllers.

30. The method of claim 28, further comprising:

5 updating the information stored in the second database every time a signal is received from the location determiner.

31. The method of any one of claims 17 to 30, further comprising:

10 providing a user interface for allowing users to query the locations of one or more objects.

32. The method of claim 31, further comprising:

determining the locations of the one or more objects based on the locations of the checkpoints and the mobile handling equipments.