

SYSTEMS AND METHODS FOR HIGH EFFICIENCY VEHICLE CONTENTS INSPECTION

BACKGROUND OF THE INVENTION

5 Field of the Invention

Embodiments of the present invention relate to inspection systems, and more particularly, to systems and methods for high efficiency vehicle contents inspection.

10 Description of the Related Art

Generally, vehicle scanning systems have been used to inspect the contents of trucks, rail cars, cargo containers, and other vessels of transport. These scanning systems are generally set up at airports, seaports, building entrances, border crossings, and other places where illegal items are likely to
15 be found in transit. Scanning systems use X-ray or gamma ray for inspection and to ensure the accuracy of shipping manifests and the like.

Conventionally, vehicle scanning systems operate at very low efficiency with big occupancy space. Thus, for 100% scanning of all transits that require few scanning systems operating concurrently, high costs are incurred and it
20 requires big building space.

When compared to prior art, the embodiments of the present invention are improvement to the US6031890 titled "Monitoring Installation for Container and truck", wherein the low energy X-ray source (140KeV) is replaced with high energy source of (1Mev -9Mev) and the drive path is shielded with shielding wall to prevent high energy X-rays from dispersing to public area for radiation safety protection. Further, the vehicle identities imaging recognition systems are also built-in inside the shielding wall zone to enormously shorten the driving path. In addition, additional improvements to the scanning process control system further eliminates the drive path before and after the shielding wall. Consequently, this increases the scanning efficiency to a very high throughput of more than 250 standard container trucks per hour.

Other Conventional art US8837670B2 titled "Cargo Inspection system" is using very complex multiple passes scanning system with rotating detector and moving gantry in order to achieved compact space to maintain throughput. The disadvantage of this system is that it is very costly due to high machinery cost in producing rotating detector and moving Gantry system. Furthermore, this system is only able to maintain but not to improve throughput.

Additional related art US20150219785A1 titled "Nonintrusive inspection method and system of cargo type object: vehicle, container trucks, train carriages" is a mobile inspection system that discloses applying automatic traffic control system with a special design boom. However, this prior art is just able to achieve up to 200 scanning ISO containers per hour. The present

invention provides novel and inventive system that has simple vehicle movement detection, which is able to achieve an almost double scanning throughput of 250 Standard ISO container trucks per hour.

Other commercial products and disclosure of the conventional art My-5
5 157628-A titled "Intelligent Security Scanning system for Inspection of a Moving Object" are having a very long drive path before and after the Radiation Protection Zone, known as "Shielding Wall". As a result, a big footprint and construction space of the system is needed causing a long driving path that reduces in scanning efficiency. Where this system installed its vehicle plate
10 recognition system before the shielding wall and reserved a long path after the shielding wall to ensure vehicle is completely exit the entire system, thus its scanning efficiency is just about 120 to 150 standard containers per hour and required system space is double.

FIG. 1 illustrates a conventional system for vehicle contents inspection
15 as per presently available prior art. Specifically, the arrangement as disclosed therein suffers from significant disadvantages, including, but not limited to, lack of process control and long machine design. As may be seen therein, the overall length is 40-60m, which requires additional space and leads to wastage of resources.

20 Accordingly, there exists a need in the art for systems and methods for high efficiency vehicle contents inspection, which provide nonintrusive high energy X-Ray vehicle scanning for land vehicles.

SUMMARY OF THE INVENTION

Embodiments of the present disclosure disclose a system for high efficiency vehicle contents inspection for inspecting a vehicle, including, a
5 vehicle entry gate for facilitating entry of the vehicle; a control unit; a shielding wall radiation zone comprising a radiation shielding wall; an exit vehicle movement monitoring device; a radiation stop sensor; and, a vehicle and container optical recognition system. In use, the system is configured to provide fast scanning comprising installation of high energy X-ray or gamma ray
10 inspection. The system further includes an incoming traffic monitoring device, a vehicle movement monitoring device, a radiation control zone, a radiation source, a detector array, a vehicle exit zone, a database server, a traffic light, a radiation monitoring device, a barrier, one or more radiation detector arrays, a radiation main beam, a vehicle passed radiation beam, and a long range remote
15 sensing device.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention,
20 briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and

are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

FIG. 1 illustrates a conventional system for vehicle contents inspection, in accordance with the prior art of the present invention;

5 FIG. 2 illustrates a block diagram of a system for high efficiency vehicle contents inspection, in accordance an embodiment of the present invention;

FIG. 3A illustrates a block diagram of a system for high efficiency vehicle contents inspection, in accordance a first embodiment of the present invention;

FIG. 3B illustrates a block diagram of a system for high efficiency vehicle
10 contents inspection, in accordance a second embodiment of the present invention;

FIG. 3C illustrates a block diagram of a system for high efficiency vehicle contents inspection, in accordance a third embodiment of the present invention;

FIG. 3D illustrates a block diagram of a system for high efficiency vehicle
15 contents inspection, in accordance a fourth embodiment of the present invention;

FIG. 3E illustrates a block diagram of a system for high efficiency vehicle contents inspection in traffic control, in accordance a fifth embodiment of the present invention; and,

20 FIG. 4 illustrates a flow diagram of a method for high efficiency vehicle contents inspection, in accordance an embodiment of the present invention.

While the present systems and methods have been described herein by way of example for several embodiments and illustrative drawings, those skilled in the art will recognize that the multiple embodiments disclosed hereinbelow are not limited to the embodiments or drawings described. It should be
5 understood, that the drawings and detailed description thereto are not intended to limit embodiments to the particular form disclosed. Rather, the intention is to cover all modifications, equivalents and alternatives falling within the scope of the invention as defined by the appended claims. Any headings used herein are for organizational purposes only and are not meant to limit the scope of the
10 description or the claims. As used herein, the word "can" and "may" is used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning must). Similarly, the words "include", "including", and "includes" mean including, but not limited to.

15 **DETAILED DESCRIPTION**

Various embodiments of the present invention relate to systems and methods for high efficiency vehicle contents inspection. Specifically, embodiments of the present invention relate to non-intrusive inspection systems and methods for identifying goods and carrier identities in
20 transportation systems. More particularly, the embodiments of the present invention relate to fast scanning control systems and methods including installation of high energy X-ray or gamma ray inspection based systems and

methods. In use, embodiments of the present invention are applicable to inspection of all type of land vehicles.

Embodiments of the present invention disclose a very high throughput and compact vehicle contents inspection system. This invention is aimed to
5 increase the operational efficiency for contents inspection of moving vehicles. In use, the present invention is aimed at providing a very compact system layout design, thereby shortening the travel distance of vehicle passing the system and increasing the inspection capacity or throughput to more than 250 standard containers or 300 small cars per hour. Furthermore, the small system footprint
10 reduces the construction cost tremendously and enables installation for site facing space constraints.

In accordance with an embodiment of the present invention, the systems as disclosed herein provide for integration of a system controller, radiation zone vehicle movement detector, exit zone vehicle movement detector, scanning
15 start signal, scanning end signal, x-ray source or generator and accelerator, one or more radiation detector arrays, radiation shielding wall, vehicle front view imaging and front registration plate recognizer, vehicle rear view imaging and rear registration plate recognizer, vehicle left side view imaging and recognizer, right side view imaging and recognizer, vehicle top view imaging and recognizer,
20 entrance traffic light and entrance barrier. In use, when the first vehicle completely passes the main radiation zone, the radiation emission is stopped by scanning end signal and the subsequence vehicle queuing in front of

shielding wall is released to enter the radiation zone without waiting for entire vehicle driving out of the radiation zone.

FIG. 2 illustrates a block diagram of a system 200 for high efficiency vehicle contents inspection. In accordance with an embodiment of the present invention, the system 200 includes, a vehicle entry gate, a control unit, a database server, a shielding wall radiation zone, a radiation source, one or more radiation detector arrays, a vehicle exit zone, a database server, an imager and recognizer.

FIG. 3A illustrates a block diagram of a system 300 for high efficiency vehicle contents inspection, in accordance a first embodiment of the present invention. In use, the system 300 for scanning vehicle 309 includes a pair of radiation shielding walls 301 that extends from a vehicle entry gate to an exit with a space therebetween that defines a radiation control zone 315, an exit vehicle movement monitoring device 302, a radiation source 303, a radiation stop sensor 304, a vehicle and container optical recognition system 305, an incoming traffic monitoring device 306, a traffic light 307, a radiation monitoring device 308, a barrier 310, one or more radiation detector arrays 311, a radiation main beam 312, a vehicle passed radiation beam 313, and a vehicle movement monitoring device 314.

FIG. 3B illustrates a block diagram of the system 300 for high efficiency vehicle contents inspection, in accordance a second embodiment of the present invention. As illustrated therein, all components are similar to FIG. 3A except

the positioning of the exit vehicle movement monitoring device 302, the vehicle and container optical recognition system 305 and the incoming traffic monitoring device 306. Similarly, FIG. 3C illustrates a block diagram of the system 300 for high efficiency vehicle contents inspection, in accordance a third
5 embodiment of the present invention, wherein all components are similar to FIG. 3A except the positioning of the vehicle and container optical recognition system 305.

FIG. 3D illustrates a block diagram of the system 300 for high efficiency vehicle contents inspection, in accordance a fourth embodiment of the present
10 invention. As illustrated therein, all components are similar to FIG. 3A except the positioning of the vehicle and container optical recognition system 305.

FIG. 3E illustrates a block diagram of the system 300 for high efficiency vehicle contents inspection in traffic control, in accordance a fifth embodiment of the present invention. As illustrated therein, all components are similar to FIG.
15 3A except the positioning of the exit vehicle movement monitoring device 302 and the vehicle and container optical recognition system 305.

FIG. 4 illustrates a flow diagram of a method 400 for high efficiency vehicle contents inspection, in accordance an embodiment of the present invention. In use, the method 400 includes the steps of, switching on a control
20 system; opening a barrier and turning traffic light to green; find the vehicle moving into a radiation control zone; switching on a radiator when the vehicle reaches a main beam zone and triggering radiation emission as switched on;

and, determining movement characteristics of the vehicle.

In accordance with an embodiment of the present invention, the method further comprises the steps of: switching off radiator when the vehicle completely passes the main beam zone; and, determining exit traffic condition.

5 In accordance with an embodiment of the present invention, the method further comprises the step of closing the barrier after the vehicle has completely passed the barrier to prevent tailed gate vehicle from entering the system.

In accordance with an embodiment of the present invention, the method further comprises the step of switching on a vehicle container and optical
10 character recognition system.

In accordance with an embodiment of the present invention, the method further comprises the step of stopping radiation emission during an emergency while determining movement characteristics of the vehicle.

In accordance with an embodiment of the present invention, the method
15 further comprises the steps of, waiting until traffic is cleared, and starting a new cycle.

As shown in **FIG. 4**, there are steps of checking if the vehicle is not moving or under a specified speed, considering the vehicle to be under an emergency condition, and stopping a radiation main beam from being fired by
20 the radiator.

As shown in **FIG. 4**, there is a step of checking an exit traffic condition after the radiator is switched off and the vehicle completely passes the main

beam zone.

As shown in **FIG. 4**, the step of checking an exit traffic condition further comprises the steps of checking if the traffic at the exit is jammed, and checking if the traffic at the exit is not jammed.

5 As shown in **FIG. 4**, the step of checking if the traffic at the exit is not jammed further comprises the steps of allowing a subsequent vehicle to enter the main beam zone and restarting a new cycle.

Therefore, as may be seen, various embodiments of the present invention disclose systems and methods for high efficiency vehicle contents
10 inspection, which provide significant advantages over the prior art, as described hereinabove. As may be seen, the present invention discloses two main approaches, which are process control and compact system design.

Specifically, in accordance with an embodiment of the present invention, the present invention discloses an approach involving a cycle time deduction
15 process control whereby continuous scanning of next vehicle with minimum or even zero waiting time is enabled. As disclosed herein, the present invention provides a system comprising a long range remote sensing device such as radar or optical vision camera to trigger radiation start/stop and the same sensor is used to perform "Exit Clearance Check". Subsequently, upon the
20 scanning completion, the sensing device will trigger the radiation to stop. Concurrently, if the sensing device confirms that the Exit is "clear", the next scanning can be started to allow next vehicle to drive into the Scanning zone.

This control method eliminates the time wasted for vehicle to pass the reserved path after the radiation main beam. In addition, with the above-mentioned control method, the reserved path after the Shielding wall can be removed to save construction cost and reduce about 25% of overall footprint.

5 Furthermore, the present invention discloses a second approach to reduce the travel distance of vehicle at the entrance path by compact machine design. As it is well known, the vehicle identities recognition system (VIR) conventionally is installed along the drive path before the Shielding wall. By compacting the VIR and installing along the Shielding wall through imaging
10 algorithm configuration and set up, the drive path before the shielding wall can be eliminated. Consequently, about another 25% of overall machine length can be reduced. In general, the total machine footprint is reduced by 50% and the “effective travel” distance of vehicle is reduced more than 70% as compares to the prior art.

15 Accordingly, while there has been shown and described the preferred embodiment of the invention is to be appreciated that the invention may be embodied otherwise than is herein specifically shown and described and, within said embodiment, certain changes may be made in the form and arrangement of the parts without departing from the underlying ideas or principles of this
20 invention within the scope of the claims appended herewith.

CLAIMS

1. A vehicle contents inspection system for inspecting contents within a moving vehicle, said system comprising:

- 5 a vehicle entry gate for facilitating entry of said vehicle;
- an exit;
- a control unit for controlling operations of said system for scanning said vehicle;
- a pair of radiation shielding walls extending from the vehicle entry gate
- 10 to the exit, having a space therebetween that defines a shielding wall radiation zone to contain dispersed and reflected radiation, which includes a main beam zone;
- a radiator, for triggering radiation emission of which a radiation main beam is emitted at the main beam zone across the radiation shielding walls to
- 15 conduct a scanning process to inspect the contents within the vehicle that passes through the main beam zone, the radiator is switched on to emit radiation when the vehicle reaches the main beam zone and is switched off when the vehicle completely passed through the main beam zone;
- an exit vehicle movement monitoring device for monitoring exit
- 20 movement of said vehicle to ensure clearance at the exit;
- a radiation stop sensor that triggers the radiation to stop; and
- a vehicle and container optical recognition system for scanning license

plate and container number of said vehicle,

wherein said system is configured to

provide scanning comprising installation of X-ray or gamma ray inspection; and

5 have its vehicle entry gate allow a subsequent vehicle to enter the shielding wall radiation zone after a prior vehicle completely passed through the main beam zone but still remaining within the shielding wall radiation zone, and upon detection of clearance of the exit by the exit vehicle movement monitoring device after the prior vehicle exits the shielding wall radiation zone through the
10 exit, the subsequent vehicle is allowed to enter the main beam zone to begin the scanning process.

2. The system as claimed in claim 1, further comprising an incoming traffic monitoring device.

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3. The system as claimed in claim 1, further comprising a database server.

4. The system as claimed in claim 1, further comprising a traffic light, one or more radiation monitoring devices, a barrier, or a combination thereof.

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5. The system as claimed in claim 1, further comprising a remote sensing device.

6. The system as claimed in claim 5, wherein the sensing device is a radar.

7. The system as claimed in claim 5, wherein the sensing device is an
5 optical vision camera.

8. The system as claimed in claim 1, wherein the system is configured to
provide a cycle time deduction process control for continuous inspection of the
subsequent vehicle.

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9. A vehicle contents inspection method for inspecting a moving vehicle
according to the vehicle contents inspection system of claim 1, said method
comprising the steps of:

switching on a control unit;

15 opening a vehicle entry gate, to allow entry of the vehicle;

passing the vehicle through a pair of radiation shielding walls extending
from the vehicle entry gate to an exit having a space therebetween that defines
a shielding wall radiation zone which includes a main beam zone;

finding said vehicle moving into a shielding wall radiation zone, by a
20 radiation stop sensor;

reaching a main beam zone, by the vehicle;

switching on a radiator when said vehicle reaches the main beam zone;

triggering radiation emission as the radiator is switched on for the emission of a radiation main beam at the main beam zone across the radiation shielding walls;

scanning and inspecting contents within the vehicle as it passes through
5 the main beam zone;

scanning license plate and container number of said vehicle using a vehicle and container optical recognition system;

passing through the main beam zone completely, by the vehicle;

triggering, by the radiation stop sensor, to stop emission of the radiation;

10 ensuring clearance at the exit using the exit vehicle movement monitoring device; and

exiting the system, by the vehicle;

wherein the method further comprises the steps of

providing scanning comprising X-ray or gamma ray; and

15 allowing a subsequent vehicle to enter the shielding wall radiation zone after a prior vehicle completely passed through the main beam zone but still remaining within the shielding wall radiation zone, and upon detection of clearance of the exit by the exit vehicle movement monitoring device after the prior vehicle exits the shielding wall radiation zone through the exit, the
20 subsequent vehicle is allowed to enter the main beam zone to begin the scanning process.

10. The method as claimed in claim 9, further comprising the steps of
opening a barrier of the vehicle entry gate;
turning a traffic light of the vehicle entry gate to green;
allowing entry of the vehicle; and
5 closing the barrier after entry of the vehicle for preventing tailgating of
the subsequent vehicle entering the system.
11. The method as claimed in claim 9, further comprising the step of stopping
radiation emission during an emergency.
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12. The method as claimed in claim 9, further comprising the step of of
waiting until traffic is cleared.
13. The method as claimed in claim 9, further comprising the step of starting
15 a new cycle.
14. The method as claimed in claim 9, further comprising the step of
providing a cycle time deduction process control for continuous inspection of
the subsequent vehicle.