

FRAUD DETECTION

Technical Field of the invention

The present invention relates to a system and a method for detection of fraud attempts directed to a reverse vending machine.

5 Background

A reverse vending machine (RVM) is a device that accepts used items, such as food and beverage containers, and returns money to the user. The machines are popular in places that have mandatory recycling laws or container deposit legislation. Reverse vending machines have been used to
10 recycle food and beverage containers for many years in order to prevent littering and conserve resources. The general system for recycling such used beverage containers is normally based on the customers bringing their used containers to a reverse vending machine and in return he or she gets a receipt back which can be exchanged to cash or used as payment in e.g. a
15 grocery store.

The reverse vending machine has been developed to accept used containers made out of a wide variety of material, such as glass or different kinds of metal and plastic. The authenticity of the container is subsequently being verified by different systems mounted in or in connection to the reverse
20 vending machine. The verification of the authenticity of the container can be based on the shape, material or other physical characteristics of the container but it can also be based on a barcode or security mark placed on the surface of the container, or a combination of such properties.

The reverse vending machine should be able to detect and handle
25 fraud attempts and based on this, the reverse vending machine shall be able to reject non-returnable items. The systems for detecting fraud attempts has become more and more sophisticated over the years, but so has also the attempts of fraud become. Therefore there is a need for constant improvements of these systems so that they meet this challenge.

30 Historically, in order to reduce fraud it has been important to provide security markings which are not easy to copy; such measures normally

requires expensive markings and/or advanced detector systems with high spatial resolution. Prior art (DE 102 47 252) has presented an example of such a system.

5 Summary of the invention

It is an object of the present invention to improve the current state of the art, to alleviate at least some of the above mentioned problems, and to provide an improved system for fraud detection in a reverse vending machine.

- According to a first aspect of the invention a system for fraud detection
- 10 in a reverse vending machine (RVM) is provided. The system comprises:
- at least one radiation emitting device configured to emit radiation within the wavelength range of optical radiation for illuminating a food or beverage container being received by said reverse vending machine,
 - at least one radiation detection device configured to detect radiation emitted
 - 15 from said at least one radiation emitting device and subsequently reflected at said food or beverage container, and/or emitted from said at least one radiation emitting device and subsequently transmitted through said food or beverage container and/or detecting radiation emitted from said food or beverage container in response to said illumination with said radiation
 - 20 detecting device;
 - processing unit in communication with said at least one radiation detecting device, wherein the processing unit is configured to:
 - receive information corresponding to the detected radiation from said at least one radiation detecting device;
 - 25 - analyzing said information corresponding to the detected radiation to determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent.
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According to an alternative first aspect of the invention the system for fraud detection in a Reverse Vending Machine comprises:

- at least one radiation emitting device configured to emit radiation within the wavelength range of optical radiation for illuminating an area of said a food or beverage container being received by said reverse vending machine, which area contains a validation mark and a background surrounding or around said validation mark, wherein said validation mark is a security mark and/or a barcode,
- at least one radiation detection device configured to detect radiation emitted from said at least one radiation emitting device and subsequently reflected at said food or beverage container, and/or emitted from said at least one radiation emitting device and subsequently transmitted through said food or beverage container and/or detecting radiation emitted from said food or beverage container in response to said illumination by said radiation detecting device;
- at least one processing unit in communication with said at least one radiation detecting device, wherein the at least one processing unit is configured to:
 - receive information corresponding to the detected radiation from said at least one radiation detecting device;
 - identify a validation area on said container, which validation area contains said validation mark and said background surrounding or around said validation mark;
 - analyzing said information corresponding to the detected radiation to determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent
 - read the validation mark contained in said validation area by use of barcode decoding and/or pattern or character recognition, and optionally
 - upon a successful reading of the validation mark classify said food or beverage container as potentially valid,

According to a second aspect of the invention a method for detecting fraud in a reverse vending machine system is provided. The reverse vending machine system has at least one radiation emitting device, a radiation detecting device and at least one processing unit, the method comprising the

- 5 steps of:
- receiving a food or beverage container;
 - illuminating the surface of said food or beverage container with radiation comprising wavelengths within the wavelength range of optical radiation, which radiation is emitted from said at least one radiation emitting device;
 - 10 - detecting radiation being emitted from said at least one radiation emitting device and subsequently reflected at said food or beverage container, and/or detecting radiation being emitted from said at least one radiation emitting device and subsequently transmitted through said food or beverage container, and/or detecting radiation emitted from said food or beverage
 - 15 container in response to said illumination with said radiation detecting device;
 - transmitting information corresponding to the detected radiation from said radiation detecting device to said at least one processing unit;
 - at said at least one processing unit:
 - analyzing said information corresponding to the detected radiation to
 - 20 determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent.

According to an alternative second aspect of the invention the method

25 for detecting fraud in a Reverse Vending Machine System having at least one radiation emitting device, a radiation detecting device and at least one processing unit, the method comprises the steps of::

- receiving a food or beverage container, which carries a validation mark and a background surrounding or around said validation mark wherein said
- 30 validation mark is a security mark or a barcode, which security mark is configured to be read/decoded by use of barcode decoding, and/or by use of character recognition and/or letter recognition and/or pattern recognition;

- illuminating the surface of said food or beverage container with radiation comprising wavelengths within the wavelength range of optical radiation, which radiation is emitted from said at least one radiation emitting device, which contains said validation mark;
- 5 - detecting radiation being emitted from said at least one radiation emitting device and subsequently reflected at said food or beverage container, and/or radiation being emitted from said at least one radiation emitting device and subsequently transmitted at said food or beverage container, and/or detecting radiation emitted from said food or beverage container in response to said
- 10 illumination with said radiation detecting device;
- transmitting information corresponding to the detected radiation from said radiation detecting device to said at least one processing unit;
- at said at least one processing unit:
 - analyzing said information corresponding to the detected radiation to
 - 15 determine the existence of additional radiation emitted from said background, which additional radiation is not received from valid food or beverage containers, and
 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent.

20 According to a third aspect of the invention, there is provided a Reverse vending machine provided with a system for fraud detection according to said first aspect of the invention.

The invention provides an easily implemented way of catching fraud requiring a less advanced detector and without requiring any special

25 markings. In other words, the essence of the invention recedes in catching fraud attempts not by verifying a security mark or a bar code, but to verify the material the security mark or bar code is printed on.

In relation to this invention, the food or beverage container handled by the reverse vending machine may also be referred to as a collected food or

30 beverage container or an empty food and beverage container or a used food and beverage container. In many reverse vending machines the container may be received also if it is not empty, and in some instance also if it has not even been opened.

The gist of this invention is applicable to a Reverse Vending Machine handling any type of consumer items for which there is a refund, examples of contemplated such machines are Reverse Vending Machine handling mobile telephones, batteries and/or packaging. I.e. the system and method may be
5 used for verifying fraud related to these items according to basically the same principles as is described with reference to food and beverage containers.

Above there is stated that said at least one processing unit is configured to receive information corresponding to the detected radiation from said at least one radiation detecting device. In other words, said at least one
10 processing unit is configured to receive information from said at least one radiation detection device, which information corresponds to, or is equal to, the radiation detected by said at least one radiation detection device.

In this document the terms "Reading" or "Decoding" should be understood as using barcode decoding, and/or character recognition and/or
15 letter recognition and/or pattern recognition to decode a message carried by a bar code, security mark or validation mark. The message may be a graphical message having a spatial extension, examples of graphical messages having a spatial extension are EAN-codes, QR-codes, letters and symbols such as a yin and yang sign.

20 Examples and embodiments of said aspects of the invention are described below.

According to at least one example embodiment of the invention optical radiation is radiation with wavelength in a range from 100 nm to 1 mm according to standard DIN 5031.

25 In relation to this invention the surface material of the food or beverage container includes the material of which the container is made out of as well as any material present on the container surface. The surface material can consist of one or several different layers, which layers in turn may consist of the same or different materials. Material present on the container surface can
30 either be placed on the container before it is sold to the costumer, e.g. a label or a tag provided by the producer and/or from the store selling such a container, or is foreign material. Foreign material is material added to the container, normally the container surface, after the container has been sold to

the customer. Foreign material can both be non-fraudulent, such as dirt, or fraudulent. Fraudulent material is provided to the food or beverage container in order to deceive the reverse vending machine to regard a non-valid container as a valid one. There are RVM:s that determine the validity of a container based on the bar code printed thereon. If the barcode corresponds to one issued by e.g. a member of the deposit association, the container will be considered valid; otherwise not. So, in order to deceive an RVM, a valid barcode is sometimes provided on top of an invalid barcode being present on the container when sold to the costumer e.g. abroad. In this example the valid barcode is foreign material, whereas the invalid barcode is not. The valid barcode could of course also be provided on a container, which did not have any barcode when sold to the costumer.

According to one example, the fraudulent container is made from scratch by e.g. a 3D-pinter, this fraudulent container may optionally include a valid bar code or security mark. In these instances the whole container represent a foreign material, which at the same time is fraudulent.

According to another example, a different object than container is used as a base, i.e. a different object than the Reverse vending machine is designed to accept. In this instance the whole object represent a foreign material, which at the same time is fraudulent.

A surface free of foreign material is referred to as the normal surface of the container.

In general, there are three ways that radiation can interact with a material or material surface, it can be reflected at, absorbed by and/or transmitted through the material or material surface. In more detail, the reflection can be diffuse and/or specular. Moreover, the illuminating radiation can be reflected at the surface and/or in the surface after the beam has penetrated the outmost surface of the food or beverage container. Furthermore, a first portion of the radiation may be reflected at a foreign material placed on the surface of the container, while a second portion of the radiation is reflected at normal surface of the container, which normal surface is arranged to the side of or beneath the foreign material.

Additionally or alternatively, the illuminating radiation can be partially or fully transmitted through the container and, optionally, simultaneously be reflected on a material placed on the container. Such material can be a foreign material, both fraudulent and non-fraudulent.

5 Additionally or alternatively, the illuminating radiation can be absorbed in the normal surface of the container and/or the foreign material, and, optionally, spontaneously radiation may be emitted from the normal surface of the container and/or foreign material. This emitted light can e.g. be due to fluorescence or similar effects.

10 According to at least one example embodiment of the invention the system for fraud detection in a reverse vending machine can be arranged in a self-contained unit to be mounted in the reverse vending machine, i.e. the unit comprises the radiation emitting device and the radiation detector device as well as the processing unit. The radiation emitting device, the radiation
15 detector device and the processing unit may also be mounted in the reverse vending machine separately. Moreover, the processing unit may be placed in the reverse vending machine but it could also be placed outside the vending machine, either in the same room or at another location. The processing unit may be connected to the reverse vending machine either by wire or wireless,
20 or by a combination wire and wireless connection.

 According to at least one example embodiment of the invention there may be several radiation emitting devices and/or several radiation detector devices. The plurality of the radiation emitting devices may be mounted in the reverse vending machine as one unit but they may also be mounted
25 separately. The radiation emitting devices might be mounted in such way that the food or beverage container receives radiation from different angles. Further, the plurality of radiation detector devices can be mounted in the reverse vending machine may be mounted as unit but they may also be mounted separately. The radiation detector devices may be mounted in such
30 a way that the radiation being scattered in different direction after reflection at or in the surface of the food or beverage container can be detected.

According to at least one example embodiment of the invention the reverse vending machine may comprise a receptacle for receiving and supporting the container when it is illuminated.

Radiation that has interacted with the container as described above, is
5 subsequently received by a radiation detection device. If the radiation detection device is sensitive to at least a portion of the received radiation wavelengths, this radiation that the radiation detection device is sensitive to will be detected and registered by the radiation detection device. The registration of radiation includes converting the detected radiation to an
10 analog and/or digital format. In relation to this invention the terms radiation registered by the radiation detection device, and radiation recorded by the radiation detection device are used interchangeably; and could also be referred to as the radiation sensed by the radiation detection device, or registered radiation or recorded radiation. In other words, registration of
15 radiation may also be referred to as recording of radiation.

In relation to this invention receiving additional radiation means receiving radiation of a predetermined wavelength range, which has a substantially higher intensity compared to the radiation received from a container where no foreign material is present. Substantially higher intensity
20 means at least 10, or at least 100, or at least 1 000 or at least 10 000 times higher compared to what is received from a valid container. Advantageously, the intensity of the additional radiation is clearly above the noise level of the radiation detector device.

According to at least one example embodiment of the invention the
25 additional radiation may be registered with a value corresponding or equal to the resulting intensity (e.g. the total recorded radiation, e.g. during a predetermined time interval and/or for one or more wavelength ranges) from one detector or from several detectors. In case one or more pixilated sensors is/are used, the resulting intensity can be as the sum of all or a sub-set of
30 these pixels. Further, the resulting intensity may be calculated via summing or integration of one or more recorded wavelengths spectra over one or more predetermined wavelength ranges.

According to at least one example embodiment of the invention

the transfer of information corresponding to the detected radiation to said processing unit, is performed only when detecting radiation comprising wavelengths outside the wavelength range received from valid food and beverage containers, and the determination of the existence of additional
5 radiation, or the determination of the existence of additional radiation emitted from said background, is equal to receiving information from said radiation detecting device.

A "processing unit", as used in this disclosure, means any machine, device, circuit, component, or module, or any system of machines, devices,
10 circuits, components, modules, or the like, which are capable of manipulating data according to one or more instructions, such as, for example, without limitation, a processor, a microprocessor, a PLC, a central processing unit, a general purpose computer, a super computer, a personal computer, a laptop computer, a palmtop computer, a notebook computer, a desktop computer, a
15 workstation computer, a server, or the like, or an array of processors, microprocessors, central processing units, general purpose computers, super computers, personal computers, laptop computers, palmtop computers, notebook computers, desktop computers, workstation computers, servers, or the like. Further, the computer may include an electronic device configured to
20 communicate over a communication link. The electronic device may include, for example, but is not limited to, a mobile telephone, a personal data assistant (PDA), a mobile computer, a stationary computer, a smart phone, mobile station, user equipment, or the like. Manipulation of some data can be accomplished so simply that relay logic can be used.

25 Moreover, the processing unit may include two or more processors. The processors may be at the same location or at different locations, either in the reverse vending machine or outside the reverse vending machine. Additionally, the processors can be connected to each other either by wire or wirelessly.

30 According to one example the processing unit comprises a processing circuitry. A first part of the processing circuitry is arranged in close vicinity of the radiation detection device, and performs a pre-processing of said recorded radiation e.g. filtering of the recorded radiation; a second part of the

processing circuitry, arranged at a different location either inside or outside of the Reverse vending machine, receives the output from pre-processing of the recorded radiation and performs subsequent processing thereof, e.g.

determines the existence of additional radiation or determines the existence

5 of additional radiation emitted from said background. According to one example, the first and second part of the processing circuitry may be arranged different circuit boards arranged at remote locations. The first and second parts of the processing circuitry are connected to each other by wire and/or wirelessly.

10 According to at least one embodiment of the invention, said at least one processing unit comprises a processing circuitry, and a first portion of said processing circuitry is arranged inside the housing of the reverse vending machine and a second portion of said processing circuitry is arranged outside the housing of the reverse vending machine; wherein said first and second
15 portions of said processing circuitry are configured to in cooperation perform said steps of:

- receive information corresponding to the detected radiation from said at least one radiation detecting device;

20 - analyzing said information corresponding to the detected radiation to determine the existence of additional radiation or to determine the existence of additional radiation emitted from said background, which additional radiation is not received from valid food or beverage containers, and

25 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent..

In relation to this invention, the term housing of the reverse vending machine refers to the outermost cover of the Reverse Vending Machine, inside which i.a. the means for transporting and/or holding the food and beverage container is arranged.

30 In relation to this invention, when actions relating to e.g. the processing of and/or storing and/or retrieving data is described, e.g. as in the two paragraphs just following this one, such actions may be performed by the processing unit and the processing circuitry therein.

According to one example, the detected and recorded radiation is compared to one or more predetermined radiation values, which radiation values each has been classified as valid or invalid. Based on this comparison, the detected and recorded radiation is determined as valid or invalid. One
 5 comparison may be performed for the whole wavelength range, or the wavelength range may be divided into subsets, and one comparison is made for each subset; each subset being associated with a respective set of predetermined radiation values.

According to one example of the invention
 10 a wavelength spectrum is detected and recorded by the radiation detection device, preferably the format of the information provided by the detector is such that different radiation intensities are linked to different predetermined wavelength ranges. Information corresponding to or representing this recorded wavelength spectrum, is transmitted to said processing unit.
 15 Thereafter, information corresponding to or representing the registered wavelength spectrum is compared to at least one classified wavelength spectrum, i.e. a known wavelength spectrum that has been classified as valid or invalid, and based on this comparison any existence of additional radiation is identified.

20 According to at least one embodiment of the invention the same or substantially the same irradiation and/or the same wavelength range is used each time radiation is detected and recorded, which recorded radiation is subsequently analyzed for the presence of additional radiation. That the same irradiation and/or the same wavelength range is used includes that the same
 25 filter (if present) is used before the light source and/or the detector each time radiation is emitted and/or detected. Even if there is a variation in the irradiation or wavelength range due to age or stability of the optical components, such as the radiation emitting device, the radiation detector and any optical filters if present etc., this is still considered to constitute use of the
 30 same or substantially the same irradiation and/or wavelength range. However, if a sequence of different illuminations (e.g. IR and visual light) is used to detect different features in e.g. security marking during different

illuminations) – this is not a use of the same or substantially the same irradiation and/or wavelength range.

Additionally or alternatively, according to at least one embodiment, when determining the presence of additional radiation the processing unit
 5 does not use pattern recognition in a 2D resolved image, additionally or alternatively nor/not feature detection, additionally or alternatively nor/not feature extraction, additionally or alternatively nor/not algorithms for detecting and isolating desired portions or shapes (features) of the container in one or more digitized image(s), e.g. in order to determine that the container is
 10 positioned and/or moves as expected. Example of recognitions/detections that are not used include edge, corner, blob and ridge detection..

Optionally, the radiation emitting device and/or the radiation detection device may comprise optical filters e.g. to make the additional radiation more easily detectable by decreasing the noise level and/or level of background
 15 illumination in the recorded radiation..

According to at least one embodiment of the invention at least one radiation emitting device emits radiation within one or more wavelength ranges selected from a group consisting of the ultraviolet range, the visible range and the infrared range. Optionally said radiation emitting device emits
 20 radiation only within said one or more wavelength ranges.

According to at least one example embodiment of the invention the radiation within the ultraviolet range is wavelengths within the range of 100 nm to 400 nm, which according to DIN 5031 may be divided into UV-C 100-280 nm, UV-B 280-400 nm and UV-A 315-400 nm. Moreover, the radiation
 25 within the visible range comprises wavelengths within the range of 400 nm to 800 nm, which may be divided into violet, bluegreen, green, yellowgreen, yellow, orange and red light. Further the radiation within the infrared range is wavelengths within the range of 800 nm to 1mm, which may be divided into IR-A 800-1400 nm, IR-B 1400 nm – 3,0 μ m and IR-C 3.0 μ m – 1 mm. The
 30 radiation source emits radiation within at least one of the above stated ranges or sub-ranges, and may emit radiation within two or more stated sub-ranges, i.e. within combinations of the above stated ranges and sub-ranges. That radiation is emitted within one wavelength range does not exclude that

radiation is also emitted outside this wavelength range. In other words, that radiation is emitted within one wavelength means that it comprises wavelength in this one wavelength range.

According to at least one example embodiment of the invention the
5 radiation emitting device can for example be one or more light emitting diodes. Further, it can be an incandescent lamp, a fluorescent lamp, or a gas discharge lamp such as a deuterium lamp or xenon lamp.

According to at least one example embodiment of the present invention the additional radiation originates from a fraudulent material present on said
10 food and beverage container.

According to at least one example embodiment of the present invention the additional radiation can be fluorescence originating from the fraudulent material in the response to the food or beverage container being irradiated with radiation in the ultraviolet range. Hence, the fluorescence may be of
15 wavelengths between 100 nm to 400 nm The fluorescence can e.g. originate from brightening agents in the paper used for the fraudulent material. It is known that bottles are fluorescent, due to e.g. a fluorescent print or a fluorescent drink that is visible through the bottle surface; a false classification of these items may be avoided, by only irradiating non-fluorescent portions of
20 such bottles.

According to another example, an illumination with NIR radiation is used. Most black pigments used in barcodes for food and beverage packaging absorb strongly at a wide range of optical wavelengths, including visible and NIR. Similarly, the black toner used in laser printing is absorptive
25 across a wide spectrum. However, the black ink used in inkjet printers, while absorptive in the visible range (400-700nm) is typically transparent to NIR wavelengths. Thus, a lamp emitting at e.g. 900nm will be reflected both at the white and black zones of the barcode, and this additional radiation may be detected and converted to a fraud assessment.

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Thus,

1) If additional radiation is not detected, the object is assumed to be valid, although it may be fraudulent (if made with a laser printer)

2) If additional radiation is detected, the object is assumed to be fraudulent, with high confidence.

Moreover, the additional radiation can be reflected radiation where a fraudulent material gives rise to a higher intensity of reflected radiation compared to the amount of radiation being reflected by the food or beverage container without the fraudulent material.

According to at least one example embodiment of the invention the fraudulent material is one or more elements selected from a group consisting of paper, plastic foils, metal foils, textiles, or bulk plastic.

According to at least one example embodiment of the invention the radiation emitting device, the radiation detection device and/or the combination thereof may be chosen by the man skilled in the art to match the optical irradiation response of the fraudulent material. I.e. by comparing the optical irradiation response from the fraudulent material to the optical irradiation response of a valid container the man skilled in the art may select the appropriate combination of radiation emitting device and radiation detection device as well as the algorithms for analyzing the recorded radiation.

According to at least one example embodiment of the invention a barcode or security marking is present on said fraudulent material, and the fraudulent material covers or replaces an original barcode or original security marking provided on said food or beverage container.

According to at least one example embodiment of the invention the fraudulent material is placed on the food or beverage container in order to achieve the reward, e.g. a receipt which can be exchanged to cash or award points,, which award would not have been received if the food or beverage container had been returned without the fraudulent material.

According to at least one embodiment of the present invention the additional radiation comprises one or more of ultraviolet radiation, fluorescent radiation, visible radiation and infrared radiation, and/or comprises radiation within one or more wavelength ranges selected from a group consisting of the ultraviolet range, the visible range and the infrared range and/or fluorescent radiation

According to at least one example embodiment of the invention the additional radiation can be radiation being reflected at and/or in the surface of the container, radiation transmitted through the surface(s) of the container as well as radiation emitted from the fraudulent material.

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According to at least one example embodiment of the invention the food or beverage container is provided with a barcode or security mark, and the radiation detection device is configured to receive light reflected at, or in the vicinity of, said barcode or security mark; and/or configured to receive
10 light emitted at, or in the vicinity of, said barcode or security mark.

According to at least one example embodiment of the invention the radiation emitting device and/or radiation detection device may optionally be configured to illuminate or detect radiation from the barcode and/or security mark and/or the vicinity of the barcode and/or the security mark. The vicinity
15 of the barcode and/or the security mark is the area around or surrounding the same. The vicinity is a distance in the range of 0 mm to 10 mm as measured outside the barcode or the security mark, and preferable a distance between 0-3 mm to the side of the code which may be suitable for a UPC or EAN code. Hence, the illuminated area and/or the area from which radiation is
20 detected may e.g. be in the range of 1700 mm² to 5500 mm².

In this document the background around and/or surrounding and/or behind a validation mark, is the area of the container in the vicinity of, but not including, the validation mark or the negative space associated with the mark. For a EAN bar code having black and white lines printed a white surface, the
25 background is both the white lines in the bar code as well as the white area surrounding the bar code.

According to at least one example embodiment of the invention there are different security markings and/or barcodes which can be present on the food or beverage container. Such as security markings may for example be
30 ink with specific spectral properties, fluorescent pigment, phosphorescent pigment, embossed patterns, or holographic films.

According to at least one example embodiment of the invention the radiation detection device is configured to detect radiation within one or more

wavelength ranges selected from a group consisting of the ultraviolet range, the visible range and the infrared range.

According to at least one example embodiment of the invention the
5 radiation detection device may comprise one or more photodiodes, and/or
one or more image sensors, such as CCD or CMOS arrays and/or one or
more camera sensors. The one or more photodiodes or image sensors may
be mounted in the reverse vending machine separated and/or remote from
each other. Further, the photodiode may be made of GaP, GaAs, Si, Ge,
10 InGaAs or HgCdTe.

According to at least one example embodiment of the invention the
information corresponding to the detected radiation which is received at said
processing unit, is received in an analog or digital format.

According to at least one example embodiment of the invention the
15 readings from the radiation detector device may be of different digital format.
Moreover, the readings from the radiation detection device can be of different
size, i.e. the amount of information collected can be different. For example,
the information can only include a signal indicative of the presence of
fraudulent material, or a spectrum of optical radiation can be collected, i.e. the
20 information contains different intensities related to different wavelengths. The
spectra collected can be within one or more of the sub-wavelength ranges
discussed above in relation to optical radiation.

According to at least one example embodiment of the invention the
information can be transferred from the radiation detection device to the
25 processing unit by wire or wirelessly or by a combination of wire and
wirelessly, i.e. one part of the distance it is communicated by wire and
another part of the distance it is communicated wirelessly.

According to at least one example embodiment of the invention the
processing unit may process the information received from the radiation
30 detection device may be in the format of an image. Such an image may be
analyzed by the use of algorithms by image processing software.

According to at least one example embodiment of the invention said
step of analyzing said information corresponding to the detected radiation to

determine the existence of additional radiation emitted from said background, which additional radiation is not received from valid food or beverage containers; further comprises the step of identifying a validation area on said container, which validation area contains said validation mark and a

5 background surrounding said validation mark.

According to at least one example embodiment of the invention, said fraudulent material preferably forms the background to said validation mark.

According to at least one example embodiment of the invention said step of determining additional radiation, or determining additional radiation
10 emitted from said background, comprises detecting a fraudulent material present on said food or beverage container, and which fraudulent material forms the background to said validation mark and which fraudulent material is optionally selected from a group consisting of paper, plastic foils, metal foils, textiles, bulk plastic or combinations of the same.

15 According to at least one example embodiment of the invention, valid containers may have a slightly fluorescent background and/or a slightly fluorescent validity marking print (e.g. a slightly fluorescent material is used for the negative and/or positive space associated with the validity marking). In order for these to be considered as valid, the analyzing said step of analyzing
20 said information corresponding to the detected radiation to determine the existence of additional radiation emitted from said background comprises the step of determining that the received radiation exceeds a predetermined intensity threshold which may be the same or different for different wavelengths, and the same or different for different container types. The
25 container type may e.g. be determined by use of the validation mark or by other conventional means. Additionally or alternatively, the processing unit may "mask off" or disregard areas of the container that is considered to be part of the validity marking print or positive space associated with the validity mark. Additionally or alternatively, only the areas of the container that is
30 considered to be part of the background or negative space associated with the validity mark is taken into consideration when performing the analyzing said step of analyzing said information corresponding to the detected

radiation to determine the existence of additional radiation emitted from said background.

Additionally or alternatively, said step of analyzing said information corresponding to the detected radiation to determine the existence of additional radiation emitted from said background comprises the step of
5 determining that the received radiation exceeds a predetermined intensity threshold which may be the same or different for different wavelengths, and the same or different for different container types. This is advantageous as it allows for classifying containers which carries a validation mark printed with
10 an ink which emits some additional radiation and/or which carries a validation mark printed on a background which some emits additional radiation as valid, by setting the intensity threshold to a predetermined value or values. I.e. if the additional radiation is lower than the intensity threshold the container is classified as valid or potentially valid; but if the additional radiation is higher
15 than the threshold the container is classified as invalid (invalid background highly fluorescing)

According to at least one example embodiment of the invention, upon determination of the non-existence of said additional radiation said food or beverage container is classified as valid or potentially valid. The food or
20 beverage container may e.g. be classified as potentially valid if further tests are to be performed before the food or beverage container is finally classified as valid, these tests are different from to those according to this invention.

The further tests may be conventional test used in known RVM machines involving a reading, decoding and/or validation of a validation mark;
25 see also page 1 lines 18-25 as stated in 2nd and 4th paragraph of the background section of this document. The test may involve that the surface area of the bottle is searched or scanned until the area that contains or seems to contain the validity mark is identified, thereafter the validation mark is read and/or decoded and/or validated e.g. by just determining that it
30 identified mark has the format of the expected validation mark, i.e. that what seems like a barcode really is a barcode; and/or by comparing the information or message in the validation mark to a stored information (within or outside the RVM) about the validation mark, e.g. that the number represented by an

EAN-code is a valid barcode, or checking the spatial correspondence between a graphical validation mark (such as a yin and yang sign) and a digital representation of the validation mark stored inside or outside the RVM machine to determine that the validation mark is valid.

- 5 According to at least one example embodiment of the invention, the steps of:
- identifying a validation area on said container, which validation area contains said validation mark and a background surrounding said validation mark;
 - 10 - performing a reading or decoding operation on the validation mark contained in said validation area by use of barcode decoding and/or letter recognition and/or character recognition and/or pattern recognition, and optionally,
 - upon a successful reading or decoding of the validation mark classify
 - 15 said food or beverage container as potentially valid are performed at said at least one processing unit, and may be performed before or after the said step of determining the existence of additional radiation emitted from said background, Thus, said at least one processing unit is configured to performing the steps recited above.

- 20 According to at least one example embodiment of the invention the same sensor reading or the same image of the container validation mark or the same information corresponding to the detected radiation from said radiation detecting device is used both when determining of the existence of additional radiation emitted from said background as well as when performing
- 25 a reading or decoding operation on the validation mark contained in said validation area by use of barcode decoding and/or letter recognition and/or character recognition and/or pattern recognition.

- According to at least one example embodiment of the invention different sensor readings or different images of the container validation mark
- 30 or different information corresponding to the detected radiation from said radiation detecting device is used both when determining of the existence of additional radiation emitted from said background compared to when performing a reading or decoding operation on the validation mark contained

in said validation area by use of barcode decoding and/or letter recognition and/or character recognition and/or pattern recognition.

According to at least one example embodiment of the invention the information, after being analyzed by the processing unit and when a fraud attempt is discovered, it may be communicated to the customer or a person monitoring the RVM, e.g. in the store where the RVM is located. Moreover, the food or beverage container is rejected if a fraud attempt has been discovered. Alternatively or additionally, the customer could be photographed and the fraudulent container retained as evidence of attempted fraud.

10 According to at least one example embodiment of the invention the at least one processing unit comprises at least a first and a second processing unit;

wherein said processing units are configured to in cooperation perform the said steps of:

- 15 - receive information corresponding to the detected radiation from said at least one radiation detecting device;
- analyzing said information corresponding to the detected radiation to determine the existence of additional radiation or to determine the existence of additional radiation emitted from said background, which additional radiation is not received from valid food or beverage containers, and
- 20 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent, and optionally
- upon determination of the non-existence of said additional radiation
- 25 classify said food or beverage container as valid or potentially valid.

According to at least one example embodiment of the invention the reading from the detector is compared to a stored valid and/or invalid wavelength spectrum using for example an ASIC or FPGA circuit in communication with a processor. Based on this comparison identifying any existence of additional radiation and hence the existence of fraudulent material.

According to at least one example embodiment of the invention the analyzing of said information corresponding to the detected radiation to determine the existence of additional radiation or to determine the existence of additional radiation emitted from said background, does not include

5 comparing information representing a spatially resolved image of the container surface to a predetermined image or information representing a predetermined image of a valid security marking. Additionally or alternatively, the analyzing of said information corresponding to the detected radiation to determine the existence of additional radiation or to determine the existence

10 of additional radiation emitted from said background, does not include the use of pattern recognition e.g. to determine that a known security mark is present. Additionally or alternatively, the additional radiation is received from the fraudulent material whereon a security marking is provided, and not from the security marking itself. In this case, what is detected and/or recognized is the

15 fraudulent material, and not the security marking. DE 102 47 252 describes the use of pattern recognition to determine that two different security marks are present; one in visual light and one in infrared light. The description explains that the method performed in e.g. DE 102 47 252, where an image of the container surface is compared to known valid security images, is not

20 performed according to this invention. According to at least one example of the invention there is no comparison of images, just a search for radiation originated from a fraudulent material.

Brief description of the drawings

25 Fig. 1 shows a schematic view of the system according to at least one example embodiment of the present invention.

Fig. 2 shows camera images of recorded fluorescence from a food or beverage container according to at least on example embodiment of the invention.

30 Fig. 3 shows spectrum from fraudulent materials

Fig. 4 shows a flow chart of a method for fraud detection according to at least one embodiment of the present invention.

Fig. 5 shows in perspective view, an example of a reverse vending machine.

Detailed description of the invention

5 In the present detailed description, embodiments of a system for fraud detection in a reverse vending machine are discussed. It should be noted that this by no means limits the scope of the invention, which is also applicable in other circumstances for instance with other types or variants of systems for fraud detection shown in the appended drawings. Further, that specific
10 components are mentioned in connection to an embodiment of the invention does not mean that those components cannot be used to an advantage together with other embodiments of the invention.

Fig. 5 shows an exemplary reverse vending machine having; object supporting, rotating, sorting and conveyor unit 3; detector device 4; receipt
15 printer activated with a button 7, and safety apparatus 8. When returning an item it is inserted into the unit through an opening in the housing of the reverse vending machine.

Fig. 1a shows an exemplary system 100 for fraud detection in a reverse vending machine. The system 100 for validation of a food or
20 beverage container 102 comprises a radiation emitting device 104 and a radiation detection device 110. Further, the system 100 comprises a processing unit (not shown in the figure).

The food or beverage container 102 is may be out of a variety of material, such as glass, or different kinds of metal or different kinds of plastic.
25 The food or beverage container 102 may be placed on a receptacle mounted in the reverse vending machine, which is configured to support the receptacle when it is illuminated.

The radiation emitting device 104 may be a source for ultraviolet radiation, visible radiation and/or infra red radiation. The radiation emitting
30 104 device may for example be an UV-LED source. Further, the system 100 can include a plurality of radiation emitting devices 104.

The radiation detection device 110 may a single photodiode, several diodes and/or a pixilated sensor. According to one example, the radiation

detector may views a portion of the container, which portion may optionally fully encircle the container in at least one plane. In Fig 1a the circle 102 is shown that fully encircles the container in one plane. Alternatively, the portion only partly encircles the container in at least one plane. Element 114 in Fig.

5 1b partly encircles the container in two planes.

The processing unit may be located at the same or different locations. The processing unit receives information from the radiation detection device and analyzes that information in order to determine if the food or beverage container 102 brought to the reverse vending machine is valid or fraudulent.

10 The system 100 may be mounted in a reverse vending machine either as a unit or separately. Further, the system 100 may include other optical devices/tools, such as optical filters, in order to further improve the fraud detection.

Fig. 1b is showing the same system 100 as fig. 1a. In addition to the parts discussed in connection to Fig 1a, Fig. 1b further shows a fraudulent material 114 being placed on the food or beverage container 102.

By illuminating the fraudulent material by the radiation emitting device 104 an additional radiation is being received at the radiation detection device 110.

The processing unit connected to the system 100 analysis information
20 detected at the radiation detection device and determine if the food or beverage container 102 is valid or fraudulent.

Fig. 2a shows a camera image which shows the fluorescent signal from a valid food or beverage container.

Fig. 2b shows a camera image which shows the fluorescent signal
25 from a fraudulent food or beverage container, the fraudulent food or beverage container being provided with bleached paper and irradiated with UV-radiation, in this example 385 nm. The text CHEAT was written on the bleached paper with an Edding 2000 permanent marker. If compared to Fig. 2a the detected radiation from the fraudulent container is more than 10 times
30 higher than the detected radiation from the valid container. Such additional radiation due to the fraudulent material is the base for rejection or classifying the container as invalid.

The combined spectrum of scattered and fluorescent light for each wavelength is shown in Fig. 3. This data was collected by illuminating a sheet of commercial-grade printer paper at close range, and collecting the scattered light with an optical fiber leading to a spectrometer. The spectra are
5 normalized so that source peaks have equal height. Fraction of signal in the fluorescence band is 87 % for 365nm, 80% for 385nm, 56 % for 405nm.

Fig. 4 shows an exemplary method 300 for fraud detection in a reverse vending machine. An appropriate system for performing the method is described in connection with Fig. 1 above. Of course, other systems may be
10 used to perform this exemplary method.

The first step 302 of the method 300 comprises receiving a food or beverage container. The used container may be received by a receptacle mounted in the reverse vending machine, which is configured to support at least during the steps in of the method presented here. The next step 304
15 comprises illuminating the surface of the food or beverage container. The radiation emitting device illuminates the surface of the container directly on or close to the barcode and/or the security marking placed on the surface of the container. The next step 306 comprises detecting radiation which has been reflected and/or emitted from the surface of the container. The reflected
20 radiation can be reflected at and/or in the surface. The emitted radiation can e.g. be fluorescence. The next step 308 comprises the transferring information from the radiation detection device to the processing unit. The next step 310 comprises analyzing of the information in the processing unit. The analyzing of the information being transferred from the radiation detection
25 device does not include pattern recognition. The analyzed results in the next step 312. This step 312 includes determining if there is an existence of fraudulent material 312a or determining if there is a non-existence of fraudulent material 312b. The flowing step 314 comprises classifying if the food or beverage container as fraudulent 314a or valid 314b.

30 It is of course understood that variations to the shown embodiment may be effected and still be within the scope of the invention. The skilled person realizes that a number of modifications of the embodiments described

herein are possible without departing from the scope of the invention, which is defined in the appended claims.

ITEMIZED LIST OF EMBODIMENTS

- 5 Item 1 A system (100) for fraud detection in a Reverse Vending Machine (1), said system comprises:
- at least one radiation emitting device (104) configured to emit radiation (106) within the wavelength range of optical radiation for illuminating a food or beverage container (102) being received by said reverse vending machine,
 - 10 - at least one radiation detection device (110) configured to detect radiation (108) emitted from said at least one radiation emitting device and subsequently reflected at said food or beverage container, and/or emitted from said at least one radiation emitting device and subsequently transmitted through said food or beverage container and/or detecting radiation emitted
 - 15 from said food or beverage container in response to said illumination by said radiation detecting device;
 - at least one processing unit (115) in communication with said at least one radiation detecting device, wherein the at least one processing unit is configured to:
 - 20 - receive information corresponding to the detected radiation from said at least one radiation detecting device;
 - analyzing said information corresponding to the detected radiation to determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
 - 25 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent.

- Item 2. A system according to item 1, wherein said at least one radiation emitting device emits radiation within one or more wavelength ranges
- 30 selected from a group consisting of the ultraviolet range, the visible range and the infrared range, and
- wherein optionally said radiation emitting device emits radiation only within said one or more wavelength ranges.

Item 3. A system according to any one of said preceding items, wherein said additional radiation originates from a fraudulent material (114) present on said food or beverage container.

5

Item 4. A system according to item 3, wherein said fraudulent material is one or more elements selected from a group consisting of paper, plastic foils, metal foils, textiles, bulk plastic or combinations of the same.

10 Item 5. A system according to item 3 or 4, wherein a barcode or security marking is present on said fraudulent material, and which fraudulent material covers or replaces an original barcode or original security marking provided on said food or beverage container, or otherwise alters the appearance of said food or beverage container.

15

Item 6. A system according to any one of the preceding items, wherein said additional radiation comprises radiation within one or more wavelength ranges selected from a group consisting of the ultraviolet range, the visible range and the infrared range and/or fluorescent radiation.

20

Item 7. A system according to any of the preceding items, wherein
- said food or beverage container is provided with a barcode or security mark, and
- said radiation detection device is configured to receive light reflected at, or in
25 the vicinity of, said barcode or security mark; and/or configured to receive light emitted at, or in the vicinity of, said barcode or security mark.

Item 8. A system according to any of the preceding items, wherein said radiation detection device is configured to detect radiation within one or more
30 wavelength ranges selected from a group consisting of the ultraviolet range, the visible range and the infrared range.

Item 9. A system according to any of the preceding items, wherein said at least one processing unit is further configured to: upon determination of the non-existence of said additional radiation classify said food or beverage container as valid or potentially valid.

5

Item 10. A system according to any of the preceding items, wherein said at least one processing unit comprises at least a first and a second processing unit;
and

10 wherein said first and second processing units are configured to in cooperation perform said steps of:
- receive information corresponding to the detected radiation from said at least one radiation detecting device;
- analyzing said information corresponding to the detected radiation to
15 determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
- upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent.

20 Item 11. A method (300) for detecting fraud in a Reverse Vending Machine System, the Reverse Vending Machine System having at least one radiation emitting device, a radiation detecting device and at least one processing unit, the method comprising the steps of:

- receiving (302) a food or beverage container;
25 - illuminating (304) the surface of said food or beverage container with radiation comprising wavelengths within the wavelength range of optical radiation, which radiation is emitted from said at least one radiation emitting device;
- detecting radiation (306) being emitted from said at least one radiation
30 emitting device and subsequently reflected at said food or beverage container, and/or radiation being emitted from said at least one radiation emitting device and subsequently transmitted at said food or beverage

container, and/or detecting radiation emitted from said food or beverage container in response to said illumination with said radiation detecting device;
 - transmitting information (308) corresponding to the detected radiation from said radiation detecting device to said at least one processing unit;

- 5 - at said at least one processing unit:
- analyzing said information (310) corresponding to the detected radiation to determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
- 10 - upon determination (312a) of the existence of said additional radiation classify said food or beverage container as fraudulent (314a).

Item 12. A method according to item 11, wherein

- said step of transmitting information corresponding to the detected radiation
- 15 to said processing unit is performed only when detecting radiation comprising wavelengths outside the wavelength range received from valid food and beverage containers, and
- said step of determine the existence of additional radiation is equal to receiving information from said radiation detecting device.

20

Item 13. A method according to item 11 or 12, further comprising the step of:

- providing information representing at least one classified wavelength spectrum to said processing unit, each of said at least one classified
- 25 wavelength spectrum being classified as valid or invalid; and wherein
- said step of detecting radiation comprises registering a wavelength spectrum;
 - said step of transmitting information corresponding to the detected radiation to said processing unit comprises transmitting information representing said
- 30 registered wavelength spectrum to said processing unit; and
- said step of determine the existence of additional radiation comprises comparing said information corresponding to the registered wavelength

spectrum to said at least one classified wavelength spectrum, and based on this comparison identifying any existence of additional radiation.

- Item 14. A method according to any of items 11-13, wherein said step of
 5 analyzing said information corresponding to the detected radiation to determine the existence of additional radiation, does not include comparing information representing a spatially resolved image of the container surface to information representing a predetermined image of a valid security marking.
- 10 Item 15. A Reverse vending machine provided with a system for fraud detection according to any one of items 1-10.

Item 16. A Reverse vending machine according to item 15, wherein said at least one processing unit comprises a processing circuitry, and a first portion
 15 of said processing circuitry is arranged inside the housing of the reverse vending machine and a second portion of said processing circuitry is arranged outside the housing of the reverse vending machine; and wherein said first and second portions of said processing circuitry are configured to in cooperation perform said steps of:

- 20 - receive information corresponding to the detected radiation from said at least one radiation detecting device;
 - analyzing said information corresponding to the detected radiation to determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
 25 - upon determination of the existence of said additional radiation classify said food or beverage container as fraudulent.

CLAIMS

1. A method (300) for detecting fraud in a Reverse Vending Machine System, the Reverse Vending Machine System having at least one radiation emitting device, a radiation detecting device and at least one
5 processing unit, the method comprising the steps of:
- receiving (302) a food or beverage container, which carries a validation mark and a background around said validation mark wherein said validation mark is a security mark or a barcode, and said background is arranged in the vicinity of said validation mark which security mark is
10 configured to be read by use of barcode decoding, and/or by use of character recognition and/or letter recognition and/or pattern recognition;
 - illuminating (304) the surface of said food or beverage container which contains said validation mark with radiation comprising wavelengths within the wavelength range of optical radiation, which radiation is emitted
15 from said at least one radiation emitting device,
 - detecting radiation (306) being emitted from said at least one radiation emitting device and subsequently reflected at said food or beverage container, and/or radiation being emitted from said at least one radiation emitting device and subsequently transmitted at said food or beverage
20 container, and/or detecting radiation emitted from said food or beverage container in response to said illumination with said radiation detecting device;
 - transmitting information (308) corresponding to the detected radiation from said radiation detecting device to said at least one processing unit;
 - at said at least one processing unit:
25 - analyzing said information (310) corresponding to the detected radiation to identify a validation area on said container, the validation area containing said validation mark and said background arranged in the vicinity of said validation mark, and determine the existence of additional radiation emitted from said background in the vicinity of said validation mark, which
30 additional radiation is not received from valid food or beverage containers, and which additional radiation comprises fluorescent radiation,
- and

- upon determination (312a) of the existence of said additional radiation classify said food or beverage container as fraudulent (314a).

2. The method according to claim 1, wherein said background
5 arranged in the vicinity of said validation mark is the background within 10 mm of said validation mark.

3. The method according to claim 1 or 2, wherein said validation area
is in the range of 1700 mm² to 5500 mm².

10

4. A method according to any of the preceding claims, wherein
- said step of transmitting information corresponding to the detected
radiation to said processing unit is performed only when detecting radiation
comprising wavelengths outside the wavelength range received from valid
15 food and beverage containers, and
- said step of determine the existence of additional radiation emitted
from said background is equal to receiving information from said radiation
detecting device.

20 5. A method according to any of the preceding claims , further
comprising the step of:
- providing information representing at least one classified wavelength
spectrum to said processing unit, each of said at least one classified
wavelength spectrum being classified as valid or invalid; and wherein
25 - said step of detecting radiation comprises registering a wavelength
spectrum;
- said step of transmitting information corresponding to the detected
radiation to said processing unit comprises transmitting information
representing said registered wavelength spectrum to said processing unit;
30 and
- said step of determine the existence of additional radiation emitted
from said background comprises comparing said information corresponding to
the registered wavelength spectrum to said at least one classified wavelength

spectrum, and based on this comparison identifying any existence of additional radiation.

6. A method according to any of claims 1-5, wherein said step of
5 analyzing said information corresponding to the detected radiation to determine the existence of additional radiation from said background, does not include comparing information representing a spatially resolved image of the container surface to information representing a predetermined image of a valid security marking or validation mark.

10

7. A method according to any one of claims 1-6, wherein at said processing unit a further test is performed comprising the steps of:
- identifying a validation area on said container, which validation area contains said validation mark and a background around said validation mark;
15 - performing a reading operation on the validation mark contained in said validation area by use of barcode decoding, and/or by use of character recognition and/or letter recognition and/or pattern recognition,
- upon a successful reading of the validation mark classify said food or beverage container as potentially valid.

20

8. A method according to any one of said preceding claims, wherein said step of determining additional radiation emitted from said background comprises detecting a fraudulent material (114) present on said food or beverage container, and which fraudulent forms the background to
25 said validation mark and optionally is selected from a group consisting of paper, plastic foils, metal foils, textiles, bulk plastic or combinations of the same.

9. A method according to any one of the preceding claims, wherein
30 said step of analyzing said information (310) corresponding to the detected radiation to determine the existence of additional radiation emitted from said background comprises the step of determining that the received radiation exceeds a predetermined threshold value,

10. A system (100) for fraud detection in a Reverse Vending Machine (1), said system comprises:

- at least one radiation emitting device (104) configured to emit
5 radiation (106) within the wavelength range of optical radiation for illuminating an area of said a food or beverage container (102) being received by said reverse vending machine, which area contains a validation mark and a background around said validation mark, wherein said validation mark is a security mark and/or a barcode, and said background is arranged in the
10 vicinity of said validation mark
- at least one radiation detection device (110) configured to detect radiation (108) emitted from said at least one radiation emitting device and subsequently reflected at said food or beverage container, and/or emitted from said at least one radiation emitting device and subsequently transmitted
15 through said food or beverage container and/or detecting radiation emitted from said food or beverage container in response to said illumination by said radiation detecting device;
- at least one processing unit (115) in communication with said at least one radiation detecting device, wherein the at least one processing unit is
20 configured to:
 - receive information corresponding to the detected radiation from said at least one radiation detecting device;
 - identify a validation area on said container, which validation area contains said validation mark and said background around said validation
25 mark;
 - analyzing said information corresponding to the detected radiation to identify a validation area on said container, the validation area containing said validation mark and said background arranged in the vicinity of said validation mark, and determine the existence of additional radiation emitted from said
30 background in the vicinity of said validation mark, which additional radiation is not received from valid food or beverage containers, and which additional radiation comprises fluorescent radiation, and

- upon determination of the existence of said additional radiation
classify said food or beverage container as fraudulent

- read the validation mark contained in said validation area by use of
barcode decoding, and/or by use of character recognition and/or letter

5 recognition and/or pattern recognition, and optionally

- upon a successful reading of the validation mark classify said food or
beverage container as potentially valid.

11. A system according to claim 10, wherein said at least one
10 radiation emitting device emits radiation within one or more wavelength
ranges selected from a group consisting of the ultraviolet range, the visible
range and the infrared range, and

wherein optionally said radiation emitting device emits radiation only
within said one or more wavelength ranges.

15

12. A system according to any one of claims 10-11, wherein said
additional radiation originates from a fraudulent material (114) present on said
food or beverage container, wherein said fraudulent material preferably forms
the background to said validation mark, and wherein said fraudulent material
20 optionally is one or more elements selected from a group consisting of paper,
plastic foils, metal foils, textiles, bulk plastic or combinations of the same.

13. A system according to claim 12, wherein validation mark is
present on said fraudulent material, and which fraudulent material covers or
25 replaces an original barcode or original security marking provided on said
food or beverage container, or otherwise alters the appearance of said food
or beverage container.

14. A system according to any one of claims 10-13, wherein said
30 additional radiation comprises radiation within one or more wavelength
ranges selected from a group consisting of the ultraviolet range, the visible
range and the infrared range and/or fluorescent radiation.

15. A system according to any of claims 10-14, wherein
- said food or beverage container is provided with a barcode or security
mark, and
- said radiation detection device is configured to receive light reflected
5 at, or in the vicinity of, said barcode or security mark; and/or configured to
receive light emitted at, or in the vicinity of, said barcode or security mark.

16. A system according to any of claims 10-15, wherein said
radiation detection device is configured to detect radiation within one or more
10 wavelength ranges selected from a group consisting of the ultraviolet range,
the visible range and the infrared range.

17. A system according to any of claims 10-16, wherein said at least
one processing unit is further configured to: upon determination of the non-
15 existence of said additional radiation classify said food or beverage container
as valid or potentially valid.

18. A system according to any of claims 10-17, wherein said at least
one processing unit comprises at least a first and a second processing unit;
20 and
wherein said first and second processing units are configured to in
cooperation perform said steps of:
- receive information corresponding to the detected radiation from said
at least one radiation detecting device;
25 - analyzing said information corresponding to the detected radiation to
determine the existence of additional radiation, which additional radiation is
not received from valid food or beverage containers, and
- upon determination of the existence of said additional radiation
classify said food or beverage container as fraudulent.

30 19. A Reverse vending machine provided with a system for fraud
detection according to any one of claims 10-18.

20. A Reverse vending machine according to claim 19, wherein said at least one processing unit comprises a processing circuitry, and a first portion of said processing circuitry is arranged inside the housing of the reverse vending machine and a second portion of said processing circuitry is
- 5 arranged outside the housing of the reverse vending machine; and
- wherein said first and second portions of said processing circuitry are configured to in cooperation perform said steps of:
- receive information corresponding to the detected radiation from said at least one radiation detecting device;
- 10 - analyzing said information corresponding to the detected radiation to determine the existence of additional radiation, which additional radiation is not received from valid food or beverage containers, and
- upon determination of the existence of said additional radiation
- 15 classify said food or beverage container as fraudulent.