(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 169 803 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.04.2023 Bulletin 2023/17

(21) Application number: **21306464.5**

(22) Date of filing: **20.10.2021**

(51) International Patent Classification (IPC):
B61L 27/53 *(2022.01)* ***B61L 27/30*** *(2022.01)*
B61L 25/08 *(2006.01)* ***G09F 9/30*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B61L 27/53; B61L 25/08; B61L 27/30

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) GENERATION SYSTEM FOR GENERATING AN IMAGE SIGNAL, RAILWAY SIGNALING SYSTEM COMPRISING SUCH GENERATION SYSTEM, ASSOCIATED METHOD AND COMPUTER PROGRAM PRODUCT

(57) Generation system (4) for generating an image signal based on a state of trackside signaling equipment (2) of a railway signaling system (1), said state being a state among a plurality of predetermined states of the trackside signaling equipment (2), at least one expected color being associated to each predetermined state, the generation system (4) comprising:
- a receiving module (10) configured for receiving a state signal comprising the state of the trackside signaling equipment (2);
- a number generator (12) configured for periodically generating a random number, each generation of a random number defining an execution cycle;
- a first channel (14), a second channel (16), a merging module (18) configured for merging a first output signal and a second output signal so as to obtain the image signal.

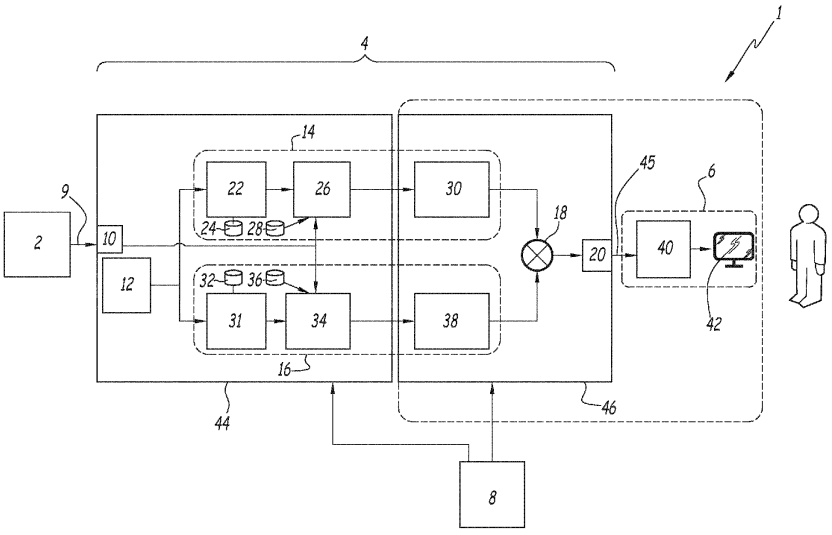

FIG.1

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Description

[0001] The present invention concerns a generation system for generating an image signal based on a state of trackside signaling equipment of a railway signaling system.

[0002] The present invention also concerns a railway signaling system comprising such a generation system.

[0003] The present invention furthermore concerns a method for generating an image signal based on a state of trackside signaling equipment of a railway signaling system.

[0004] The present invention also concerns a related computer program product.

[0005] The invention relates to the technical field of monitoring and control of safety-related data, in particular of signals or states of a railway signaling system.

[0006] Operators in railway signaling systems are required to take decisions and perform actions based on data displayed on a screen, for example in a control center or in a railway vehicle. The displayed data comprise for example a schematic plan of a railway infrastructure along with states of light signals, block occupation indications, states of switch points, etc.

[0007] In order to guarantee safety of the railway infrastructure, the displayed data or information must satisfy strict integrity requirements. For example, the displayed data must fulfil the requirements of SIL (Safety Integrity Level) 2 or level 4.

[0008] Conventionally, the safety-related data is processed using specific safety related equipment to generate an image signal. The equipment must satisfy in particular the required SIL. The image signal is then transferred to a dedicated graphical user interface, which also fulfils the required SIL, in order to be displayed. A number of requirements, for example concerning the choice of specific hardware, such specific processors, memories, etc. render the equipment complex. Also, the equipment is difficult to modify for example in case of a modification of the signaling system or the railway infrastructure.

[0009] In addition, there is often non-safety related data to be displayed to the operator, such as non-safety related performance data of railway vehicles, power consumption, etc...

[0010] The non-safety related data is often displayed on a screen distinct from a screen displaying the safety-related data. This is not convenient for the operator and compromises the overall control performance of the signaling system. Also, it is not efficient to display the non-safety related data by using the equipment satisfying SIL2 or SIL4, as this safety related equipment requires high computation performance.

[0011] An aim of the present disclosure is to remedy the above-mentioned drawbacks.

[0012] In particular, an object of the present disclosure is to provide a generation system for generating an image signal, wherein the generation system is particularly simple and allows obtaining a required safety integrity level at the same time.

[0013] According to one aspect, the present invention relates to a generation system for generating an image signal based on a state of trackside signaling equipment of a railway signaling system, said state being a state among a plurality of predetermined states of the trackside signaling equipment, at least one expected color being associated to each predetermined state, the generation system comprising:

- a receiving module configured for receiving a state signal comprising the state of the trackside signaling equipment;
- a number generator configured for periodically generating a random number, each generation of a random number defining an execution cycle;
- a first channel comprising:

    + a first base color module configured for providing, for each execution cycle, a first list comprising a first base color for each expected color, each first base color of said first list being based on the random number corresponding to this execution cycle;
    + a first generation module configured for selecting, for each execution cycle, a first base color from the first list corresponding to this execution cycle, based on the state signal, so as to provide a selected first base color;

- a second channel comprising:

    + a second base color module configured for providing, for each execution cycle, a second list having a second base color for each expected color, each second base color of said second list being based on the random number corresponding to this execution cycle;
    + a second generation module configured for selecting, for each execution cycle, a second base color from the second list corresponding to this execution cycle, based on the state signal, so as to provide a selected second base color;

- a merging module configured for merging, for each execution cycle, a first output signal comprising the selected first base color and a second output signal comprising the selected second base color so as to obtain the image signal, wherein the image signal comprises the expected color associated to the state of the state signal;
- a transmission module configured for transmitting, for each execution cycle, the image signal to a user interface.

[0014] Indeed, thanks to the fact that, at each execution cycle, the first and second base colors corresponding to the generated random number are provided and merged, an error or incoherence of the expected color in the image signal is detectable.

[0015] For example, in case of software or hardware fault, the expected color, which is provided in the image signal, changes at each execution cycle. This is because, in this case, the merging of two base colors does not result in the color which corresponds to the expected color. As a result, the color in the image signal shows a continuous changing of different random colors, in a frequency of the execution cycles.

[0016] An operator or a machine is able to recognize this continuous changing, and is thus able to detect that there is a fault in the image signal generation. This means for example that the data displayed on the user interface is not to be trusted.

[0017] As a consequence, if one of the channels provides an erroneous selected base color, such error is detectable as the expected color obtained in the image signal changes. Similarly, if the merging module merges the first and second base colors in an erroneous way so as to provide a color which is not associated to the state of the state signal, this is detectable in the image signal by color changing.

[0018] Thus, the required integrity level of the image signal is obtained. At the same time, the generation system is particularly simple because hardware components do not require to satisfy a specific integrity level. For example, the generation system enables the use of commercial-off-the-shelf hardware.

[0019] Further embodiments may relate to one or more of the following features, which may be combined in any technical feasible combination:

- the merging module comprises an XOR-operator configured for receiving the first output signal and the second output signal as inputs of the XOR-operator, and for providing the image signal as an output of the XOR-operator.
- the selected first base color and the selected second base color are values expressed in binary code.
- the first output signal comprises a series of first images defined by a plurality of pixels, at least one pixel of the series of first images preferably comprising the selected first base color.
- the second output signal comprises a series of a second images defined by a plurality of pixels, at least one pixel of the series of second images preferably comprising the selected second base color.
- the first channel further comprises a first conversion module configured for receiving, from the first generation module, a first intermediate signal comprising vector image data comprising the selected first base color, and for converting the first intermediate signal into the first output signal.
- the second channel further comprises a second conversion module configured for receiving, from the second generation module, a second intermediate signal comprising vector image data comprising the selected second base color, and for converting the second intermediate signal into the second output signal.
- the first channel further comprises at least one first image database comprising first stationary image data relative to the trackside signaling equipment, the first generation module being configured for generating the first intermediate signal in function of the first stationary image data and the selected first base color.
- the second channel comprises at least one second image database comprising second stationary image data relative to the trackside signaling equipment, the second generation module being configured for generating the second intermediate signal in function of the second stationary image data and the selected second base color.
- the first stationary image data and the second stationary image data are equivalent.
- the generation system further comprises at least one base color database comprising indexes corresponding to the random numbers, the base color database comprising, for each index and for each expected color, a corresponding first base color and/or a corresponding second base color.
- for each index and for each expected color, the corresponding first base color and the corresponding second base color are determined so as to satisfy the following condition: the corresponding first base color merged with the corresponding second base color by the merging module results in the expected color.
- for each expected color, the first base color associated to the index equal to N is different from the first base color associated to the index equal to N+1 and to the index equal to N-1, wherein N is a positive integer.
- for each expected color, the second base color associated to the index equal to N is different from the second base color associated to the index equal to N+1 and to the index equal to N-1.
- the receiving module, the number generator, the first and second base color modules and the first and second generation modules are implemented by a first calculator, and the merging module is implemented by at least one second calculator distant to the first calculator.

- the image signal comprises the expected colors associated to the state of a plurality of devices of the trackside signaling equipment.

[0020] The invention further relates to a railway signaling system comprising trackside signaling equipment, a generation system and a user interface, wherein the generation system is as described above.

[0021] The invention also relates to a method for generating an image signal based on a state of trackside signaling equipment of a railway signaling system, said state being a state among a plurality of predetermined states of the trackside signaling equipment, at least one expected color being associated to each predetermined state. The method comprises:

- a receiving step comprising the reception of a state signal comprising the state of the trackside signaling equipment;
- a number generating step comprising the generation of a random number, the generation of the random number defining an execution cycle;
- a first providing step comprising the provision, for each execution cycle, of a first list comprising a first base color for each expected color, each first base color of said first list being based on the random number corresponding to this execution cycle;
- a first selecting step comprising the selection, for each execution cycle, of a first base color from the first list corresponding to this execution cycle, based on the state signal, so as to provide a selected first base color;
- a second providing step comprising the provision, for each execution cycle, of a second list having a second base color for each expected color, each second base color of said second list being based on the random number corresponding to this execution cycle;
- a second selecting step comprising the selection, for each execution cycle, of a second base color from the second list corresponding to this execution cycle, based on the state signal, so as to provide a selected second base color;
- a merging step comprising the merging, for each execution cycle, of a first output signal comprising the selected first base color and a second output signal comprising the selected second base color so as to obtain the image signal, wherein the image signal comprises the expected color associated to the state of the state signal;
- a transmission step comprising the transmission, for each execution cycle, of the image signal to a user interface.

[0022] The invention further relates to a computer program product comprising software instructions which, when executed by a computer, implement a method as described above.

[0023] These features and advantages of the invention will be further explained in the following description, given only as a non-limiting examples, and with reference to the attached drawing, wherein figure 1 is a schematic view of a railway signaling system comprising a generation system according to the invention.

[0024] With reference to figure 1, a railway signaling system 1 comprises trackside signaling equipment 2, a generation system 4 and a user interface 6. Optionally, the railway signaling system 1 furthermore comprises additional signaling equipment 8 configured for transmitting non-safety related data.

[0025] The trackside signaling equipment 2 comprises for example a plurality of devices installed along a railway track, such as one or more lights for indicating the occupation of a track section, one or more signals for indicating a state of a switch points, and/or one or more signals of level crossings.

[0026] The trackside signaling equipment 2 is configured for generating and transmitting safety-related data.

[0027] Each device of the trackside signaling equipment 2 presents at least two different predetermined states. In the example of a light, the predetermined state is for example chosen from "occupied' for indicating the presence of a railway vehicle in a corresponding track section, "clear" for indicating that no railway is present in the corresponding track section, "device out of service" and "railway vehicle in opposite direction".

[0028] The trackside signaling equipment 2 is configured for transmitting, for example via a corresponding data connection 9, such as a cabled or wireless connection, a state signal comprising the or each current state of equipment 2 to the generation system 4.

[0029] The generation system 4 is configured for generating an image signal based on the state of the signaling equipment 2, and to transmit the image signal to the user interface 6.

[0030] The generation system 4 satisfies in particular at least Safety Integrity Level (SIL) 2, preferably SIL 3 or 4.

[0031] The generation system 4 comprises for example, and preferably consists of, commercial-off-the shelf (COTS) hardware components.

[0032] The generation system 4 comprises a receiving module 10, a number generator 12, a first channel 14, a second channel 16, a merging module 18 and a transmission module 20.

[0033] The receiving module 10 is configured for receiving the state signal from the trackside signaling equipment 2.

[0034] The number generator 12 is configured for periodically generating a random number, for example at a constant frequency, such a frequency comprised between 1 to 4 Hz, preferably equal to 2 Hz.

[0035] Each generation of a random number defines an execution cycle of the generation system 4. An operation

cycle presents thus for example a duration comprised between 0,25 seconds and 1 second, and is preferably substantially equal to 0,5 seconds.

[0036] A duration of each operation cycle comprised between 0,25 and 1 seconds allows taking into account the reaction time of a human operator, and shows at the same time a blinking effect of the color in the image signal in case of erroneous calculation. Also, such a duration requires low calculation power.

[0037] The number generator 12 is for example a pseudo random number generator, configured for generating pseudo random numbers in a predetermined manner, for example starting from a predetermined initial value, also called seed.

[0038] The first channel 14 is configured for providing a selected first base color and the second channel 16 is configured for providing a selected second base color. The selected first and second base colors are chosen such that, in the absence of failure of the channels 14, 16 or of the merging module 18, the merging of the selected first and second base colors results in an expected color which is associated to the state of the state signal received from the equipment 2.

[0039] In particular, each selected first base color and each selected second base color is different from the expected color they are associated with.

[0040] For example, the expected color "RED" is associated to a device of the trackside signaling equipment 2 indicating the predetermined state "occupied' and the expected color "GREEN" is associated to a device indicating the predetermined state "clear".

[0041] The first channel 14 comprises a first base color module 22, a first base color database 24, a first generation module 26, a first image database 28 and a first conversion module 30.

[0042] The first base color module 22 is configured for receiving the random number from the number generator 10 and for sending a request comprising this random number to the first base color database 24 in order to obtain in response, for each expected color, a first base color, corresponding to the received random number.

[0043] The first base color module 22 is configured for providing a first list comprising the first base colors received from the first base color database 24. The first list is specific to the random number of the execution cycle, and comprises, for each expected color, a corresponding first base color. Each first base color of the first list is based on the random number corresponding to this execution cycle.

[0044] The first base color database 24 comprises for example indexes corresponding to the random numbers. The base color database comprises in particular, for each index and for each expected color, a corresponding first base color.

[0045] For example, the first base color database 24 comprises a register for the expected color "RED". In this register, a first column indicates the indexes 1, 2, 3, 4, ... N where N is the highest possible random number. A second column comprises the corresponding first base color, such as purple for index 1, yellow for index 2, etc. N is in particular a positive integer.

[0046] In particular, the first base color database 24 comprises, for each index and for each expected color, a predetermined first base color so as to satisfy the following condition: the first base color merged with a second base color corresponding to the same index, by the merging module 18, results in the expected color.

[0047] Preferably, the first base color database 24 comprises, for each expected color, a first base color associated to the index equal to N which is different from the first base color associated to the index equal to N+1 and to the index equal to N-1.

[0048] Preferably, the first base colors of the first base color database 24 are, for each expected color, different one from each other, for each index.

[0049] The first generation module 26 is configured for selecting, for each execution cycle, a first base color from the first list corresponding to this execution cycle, based on the state signal, so as to provide the selected first base color. According to an example, the generation module 26 comprises a database, not shown, associating each predetermined state to a corresponding expected base color. For example, if the received state of the state signal is the state "occupied', the module 26 selects the first base color which corresponds to the expected base color "RED" from the first list.

[0050] The generation module 26 is configured for generating a first intermediate signal comprising vector image data.

[0051] The vector image data comprises at least the selected first base color.

[0052] The generation module 26 is for example further configured for requesting the first image database 28 to receive first stationary image data, and to include the first stationary image data into the first intermediate signal.

[0053] In particular, the first intermediate signal generated by the generation module 26 comprises vector image data forming a vector based image. The vector based image comprises a plurality of elements. The elements are stationary, such as the first stationary image data, or dynamic, such as the first base color associated to the expected color.

[0054] The first stationary image data of the first image database 28 comprises data relative to the trackside signaling equipment 2. For example, the data depends on the structure of a railway system in which the railway signaling system 1 is implemented. These data comprise for example schematic images of rails, level crossings, switch points, train stations, and types of lights.

[0055] The first conversion module 30 is configured for receiving the first intermediate signal from the first generation module 26, and for converting the first intermediate signal into a first output signal.

[0056] The first output signal comprises in particular a plurality of pixels adapted to a number of pixels of an image to

be displayed by the user interface 6.

[0057] In particular, the first output signal comprises a series of a first images defined by a plurality of pixels. At least one of these pixels comprises in particular the selected first base color.

[0058] The first conversion module 30 is for example configured for converting the signals by using a technical called rasterization, for example by using Commercial Off The Shelf graphical libraries, so as to convert the vector based image comprised in the first intermediate signal into a raster bitmap comprised in the first output signal.

[0059] The second channel 16 is configured to operate in parallel to the first channel 14.

[0060] The second channel 16 is configured for receiving, simultaneously to the first channel 14, the random number corresponding to the current execution cycle, identical to the random number received by the first channel 14 for this execution cycle.

[0061] The second channel 16, and in particular the second conversion module 38, is configured for providing a second output signal analogous to the first output signal. The second output signal comprises the selected second base color, provided in an analogous manner to the selected first base color. In particular, the second output signal comprises a series of a second images defined by a plurality of pixels. At least one of these pixels comprises in particular the selected second base color.

[0062] The second channel 16 comprises in particular modules which are configured to operate in an analogous manner compared with the modules of the first channel 14.

[0063] By "analogous", it is in particular understood that each module of channel 16 is configured to perform the same functions as the corresponding module of channel 14, starting from the second base color instead of the first base color.

[0064] The second channel 16 comprises a second base color module 31 analogous to the first base color module 22, a second base color database 32 analogous to the first base color database 24, a second generation module 34 analogous to the first generation module 26, a second image database 36 analogous to the first image database 28 and a second conversion module 38 analogous to the first conversion module 30.

[0065] For example, the first stationary image data of the first image database 28 is equivalent to second stationary image data of the second image database 36. By "equivalent", it is understood that the data are such that, when the first stationary image data is merged with the second stationary image data, they merged data forms a stationary part of a trackside signaling equipment 2 of the image signal. For example, the first and second stationary image data correspond, merged together, to a pillar of a traffic light or to a symbol of a track switch.

[0066] For example, the first base color database 24 comprises the first base colors and the second base color database 32 comprises the second base colors, which are complementary to the first base colors so as to form the expected color.

[0067] According to an example, the first base color database 24 and the second base color database 32 are two separated databases. According to another example, they are integrated in one single database.

[0068] An example of an initialization of the first base color database 24 and the second base color database 32 is described hereafter.

[0069] The first base color database 24 is for example initialized by the generation device 4 by a first rotating mask applied on each bit value of each expected color, so as to generate the first base color according to the following formula:

$$\text{“First base color”} = (\text{“Expected color”} \,\&\, \text{“MASK 1”}) \,\hat{}\, \text{“random number 1”},$$

wherein:

the operator "&" designates a bitwise "and",
the operator "^" designates a bitwise XOR,
the value "MASK 1" designates the first rotating mask,
the value "random number 1" designates a first random number.

[0070] An example of initial value for the first rotating mask MASK 1 is #63639C.

[0071] The second base color database 32 is for example initialized by the generation device 4 by a second rotating mask applied on each bit value of each expected color, so as to generate the second base color according to the following formula:

$$\text{“Second base color”} = (\text{“Expected color”} \,\&\, \text{“MASK 2”}) \,\hat{}\, \text{“random number 2”},$$

wherein:

the value "MASK 2" designates the second rotating mask,
the value "random number 2" designates a second random number.

[0072] An example of initial value for second rotating mask MASK 2 is #9C9C63. This value corresponds to the example of the first rotating mask being #63639C.

[0073] The first and second random numbers are different so as to satisfy the following condition:

$$\text{“random number 1”} \wedge \text{“random number 2”} = 0.$$

[0074] The merging module 18 is configured for merging, for each execution cycle, the first output signal and the second output signal so as to obtain the image signal. The image signal comprises the expected color associated to the state of the state signal.

[0075] The merging module 18 comprises for example an XOR-operator, also called "exclusive-or-operator", configured for receiving the first output signal and the second output signal as inputs of the XOR-operator, and for providing the image signal as an output of the XOR-operator.

[0076] For example, the selected first base color and the selected second base color are values expressed in binary code.

[0077] For example, the merging module 18 is configured for determining, for each binary value of the first output signal and the second output signal, the corresponding binary value of the image signal as follows, wherein the operator "^" designates the merging of two values:

$$1 \wedge 0 = 0 \wedge 1 = 1, \text{ and}$$

$$0 \wedge 0 = 1 \wedge 1 = 0.$$

[0078] In particular, the merging module 18 is configured for implementing the following formula:

$$\text{“selected first base color”} \wedge \text{“selected second base color”} = \text{“expected color”}.$$

[0079] This forms, by taking into account the above definition for the first base color and the second base color:

$$\text{“selected first base color”} \wedge \text{“selected second base color”} = ((\text{“expected color”} \,\&\, \text{“MASK 1”}) \wedge \text{“random number 1”}) \wedge ((\text{“expected color”} \,\&\, \text{“MASK 2)} \wedge \text{“random number 2”}).$$

[0080] For example, the first output signal comprises the selected first base color expressed in binary code as:
1000 1010 0100 1010 0100 1011.

[0081] According to this example, the second output signal comprises the selected second base color expressed in binary code as:
1011 1001 1101 0011 1011 0100.

[0082] In this case, the merging module 18 is configured to obtain the image signal comprising the following expected color expressed in binary code:
0011 0011 1001 1001 1111 1111.

[0083] The transmission module 20 is configured for transmitting, for each execution cycle, the image signal to the user interface 6 via a data connection 45.

[0084] The user interface 6 comprises for example a screen controller 40 and a screen 42. The screen controller 40 is configured for receiving the image signal and to control the screen 42 so that the screen 42 displays the image of the image signal.

[0085] The additional signaling equipment 8 is configured for providing additional data which is in particular not safety related, such as for example non-safety related performance data of railway vehicles, power consumption and train timetables.

[0086] For example, the additional signaling equipment 8 is configured for providing the additional data to the merging module 18 so that the merging module 18 includes the additional data into the image signal.

[0087] According to another example, the additional signaling equipment 8 is configured for providing the additional data to the first and/or second channel 14, 16, so that first output signal and/or the second output signal comprises the additional data.

[0088] The combination of the additional signaling equipment 8 with the channels 14, 16 and the merging module 18 allows in particular displaying safety-related and non-safety related information together via the user interface 6.

[0089] With reference to the example of figure 1, the receiving module 10, the number generator 12, the first and second base color modules 22, 31 and the first and second generation modules 26, 34 are implemented by a first calculator 44, also designated as a server.

[0090] For example, the merging module 18, and optionally the first and second conversion modules 30, 38, is/are implemented by at least one second calculator 46, also designated as a client.

[0091] According to an example, a plurality of second calculators 46 are connected to the first calculator 44.

[0092] The second calculator 46 is distant to the first calculator. For example, the first calculator 44 is located in a first building, and the second calculator 46 is located in a second building different from the first building.

[0093] For example, the second calculator 46 is located in a control center or on board of a railway vehicle.

[0094] According to an example, the second calculator and the user interface 6 form together a user terminal, for example located in a single housing.

[0095] According to an example, the image signal comprises data relative a plurality of devices of the trackside signaling equipment 2. In this case, the state signal comprises the state of a plurality of devices of the trackside signaling equipment 2. In this case, preferably the first output signal comprises the selected first base color of each device of the plurality of devices of the trackside signaling equipment 2, and the second output signal comprises the selected second base color of each device.

[0096] A method for generating an image signal based on the state of trackside signaling equipment 2 is now described. The method is implemented by the generation system 4.

[0097] The method comprises for example an initialization phase and an operation phase.

[0098] During the initialization phase, the generation system 4 initializes the first base color database 24 and the second base color database 32. In particular, the generation system 4 configures the first base color database 24 with a first base color for each index and for each expected color, and the second base color database 24 with a second base color for each index and for each expected color.

[0099] The operation phase comprises a receiving step, a number generating step, a first providing step, a first selecting step, a second providing step, a second selecting step, a merging step and a transmission step.

[0100] During the receiving step, the receiving module 10 receives the state signal comprising the state of the trackside signaling equipment 2.

[0101] During the number generating step, the number generator 12 generates a random number. The generation of the random number defines the execution cycle.

[0102] During the first providing step, the first base color module 22 provides, for the current execution cycle and based on the random number corresponding to this execution cycle, the first list.

[0103] During the first selecting step, the first generation module 26 selects a first base color from the first list corresponding to the current execution cycle, based on the state signal, so as to provide the selected first base color.

[0104] During the second providing step, the second base color module 31 provides, for the current execution cycle and based on the random number corresponding to this execution cycle, the second list in an analogous manner to the provision of the first list.

[0105] During the second selecting step, the second generation module 34 selects a second base color from the second list corresponding to the current execution cycle, based on the state signal, so as to provide the selected second base color.

[0106] The first providing step and the first selecting step are preferably executed in parallel, in particular simultaneously, to the second providing step and the second selecting step.

[0107] During the merging step, the merging module 18 merges, for a given execution cycle, the first output signal comprising the selected first base color and the second output signal comprising the selected second base color so as to obtain the image signal. In particular, the merging module 18 merges the first output signal with the second output signal which is associated to the same execution cycle.

[0108] During the transmission step, the transmission module 20 transmits the image signal to the user interface 6.

[0109] The method is for example repeated for each execution cycle defined by the generation of the random number.

[0110] The present invention presents many advantages.

[0111] The generation system 4 is particularly simple and allows obtaining a required safety integrity level at the same time, because thanks to the architecture having two channels 14 and 16, the color comprised in the image signal changes at each execution cycle in case of a failure of one or both channels 14, 16.

[0112] The change of the color allows thus detection of a failure and allows obtaining the required safety integrity level.

[0113] In case of a failure, thanks to the generation system 4, generally only a part of the image shown on the user

interface 6, or even only one pixel, is subject to blinking. This alerts the operator that a failure occurs, without corrupting the entire image. Thus, the operator is warned, but at the same time, the image is still displayed.

[0114] The generation system 4 furthermore allows mixing of non-safety related data and safety related data in same user interface 6, in particular on one single screen 42.

[0115] Also, the generation system has low requirements on computing power, as the channels 14, 16 are simple and the merging module 18 is configured to implement simple calculation, such as an XOR-operator.

Claims

1. Generation system (4) for generating an image signal based on a state of trackside signaling equipment (2) of a railway signaling system (1), said state being a state among a plurality of predetermined states of the trackside signaling equipment (2), at least one expected color being associated to each predetermined state, the generation system (4) comprising:

    - a receiving module (10) configured for receiving a state signal comprising the state of the trackside signaling equipment (2);
    - a number generator (12) configured for periodically generating a random number, each generation of a random number defining an execution cycle;
    - a first channel (14) comprising:

        + a first base color module (22) configured for providing, for each execution cycle, a first list comprising a first base color for each expected color, each first base color of said first list being based on the random number corresponding to this execution cycle;
        + a first generation module (26) configured for selecting, for each execution cycle, a first base color from the first list corresponding to this execution cycle, based on the state signal, so as to provide a selected first base color;

    - a second channel (16) comprising:

        + a second base color module (31) configured for providing, for each execution cycle, a second list having a second base color for each expected color, each second base color of said second list being based on the random number corresponding to this execution cycle;
        + a second generation module (34) configured for selecting, for each execution cycle, a second base color from the second list corresponding to this execution cycle, based on the state signal, so as to provide a selected second base color;

    - a merging module (18) configured for merging, for each execution cycle, a first output signal comprising the selected first base color and a second output signal comprising the selected second base color so as to obtain the image signal, wherein the image signal comprises the expected color associated to the state of the state signal;
    - a transmission module (20) configured for transmitting, for each execution cycle, the image signal to a user interface (6).

2. Generation system (4) according to claim 1, wherein the merging module (18) comprises an XOR-operator configured for receiving the first output signal and the second output signal as inputs of the XOR-operator, and for providing the image signal as an output of the XOR-operator.

3. Generation system (4) according to claim 1 or 2, wherein the selected first base color and the selected second base color are values expressed in binary code.

4. Generation system (4) according to any one of the preceding claims, wherein the first output signal comprises a series of first images defined by a plurality of pixels, at least one pixel of the series of first images preferably comprising the selected first base color, and/or
wherein the second output signal comprises a series of a second images defined by a plurality of pixels, at least one pixel of the series of second images preferably comprising the selected second base color.

5. Generation system (4) according to any one of the preceding claims, wherein the first channel (14) further comprises

a first conversion module (30) configured for receiving, from the first generation module (26), a first intermediate signal comprising vector image data comprising the selected first base color, and for converting the first intermediate signal into the first output signal, and/or
wherein the second channel (16) further comprises a second conversion module (38) configured for receiving, from the second generation module (34), a second intermediate signal comprising vector image data comprising the selected second base color, and for converting the second intermediate signal into the second output signal.

6. Generation system (4) according to claim 5, wherein the first channel (14) further comprises at least one first image database (28) comprising first stationary image data relative to the trackside signaling equipment (2), the first generation module (26) being configured for generating the first intermediate signal in function of the first stationary image data and the selected first base color, and/or
wherein the second channel (16) comprises at least one second image database (36) comprising second stationary image data relative to the trackside signaling equipment (2), the second generation module (34) being configured for generating the second intermediate signal in function of the second stationary image data and the selected second base color.

7. Generation system (4) according to claim 6, wherein the first stationary image data and the second stationary image data are equivalent.

8. Generation system (4) according to any one of the preceding claims, further comprising at least one base color database (24, 32) comprising indexes corresponding to the random numbers, the base color database (24, 32) comprising, for each index and for each expected color, a corresponding first base color and/or a corresponding second base color.

9. Generation system (4) according to claim 8, wherein, for each index and for each expected color, the corresponding first base color and the corresponding second base color are determined so as to satisfy the following condition: the corresponding first base color merged with the corresponding second base color by the merging module results in the expected color.

10. Generation system (4) according to claim 8 or 9, wherein, for each expected color, the first base color associated to the index equal to N is different from the first base color associated to the index equal to N+1 and to the index equal to N-1, wherein N is a positive integer, and/or
wherein, for each expected color, the second base color associated to the index equal to N is different from the second base color associated to the index equal to N+1 and to the index equal to N-1.

11. Generation system (4) according to any one of the preceding claims, wherein the receiving module (10), the number generator (12), the first and second base color modules (22, 31) and the first and second generation modules (26, 34) are implemented by a first calculator (44), and the merging module (18) is implemented by at least one second calculator (46) distant to the first calculator (44).

12. Generation system (4) according to any one of the preceding claims, wherein the image signal comprises the expected colors associated to the state of a plurality of devices of the trackside signaling equipment (2).

13. Railway signaling system (1) comprising trackside signaling equipment (2), a generation system (4) and a user interface (6), wherein the generation system (4) is according to any one of the preceding claims.

14. Method for generating an image signal based on a state of trackside signaling equipment (2) of a railway signaling system (1), said state being a state among a plurality of predetermined states of the trackside signaling equipment (2), at least one expected color being associated to each predetermined state, the method comprising:

- a receiving step comprising the reception of a state signal comprising the state of the trackside signaling equipment (2);
- a number generating step comprising the generation of a random number, the generation of the random number defining an execution cycle;
- a first providing step comprising the provision, for each execution cycle, of a first list comprising a first base color for each expected color, each first base color of said first list being based on the random number corresponding to this execution cycle;
- a first selecting step comprising the selection, for each execution cycle, of a first base color from the first list

corresponding to this execution cycle, based on the state signal, so as to provide a selected first base color;
- a second providing step comprising the provision, for each execution cycle, of a second list having a second base color for each expected color, each second base color of said second list being based on the random number corresponding to this execution cycle;
- a second selecting step comprising the selection, for each execution cycle, of a second base color from the second list corresponding to this execution cycle, based on the state signal, so as to provide a selected second base color;
- a merging step comprising the merging, for each execution cycle, of a first output signal comprising the selected first base color and a second output signal comprising the selected second base color so as to obtain the image signal, wherein the image signal comprises the expected color associated to the state of the state signal;
- a transmission step comprising the transmission, for each execution cycle, of the image signal to a user interface (6).

15. Computer program product comprising software instructions which, when executed by a computer, implement a method according to the preceding claim.

Amended claims in accordance with Rule 137(2) EPC.

1. Generation system (4) for generating an image signal based on a state of trackside signaling equipment (2) of a railway signaling system (1), said state being a state among a plurality of predetermined states of the trackside signaling equipment (2), at least one expected color being associated to each predetermined state, the generation system (4) comprising:

- a receiving module (10) configured for receiving a state signal comprising the state of the trackside signaling equipment (2);
- a number generator (12) configured for periodically generating a random number, each generation of a random number defining an execution cycle;
- a first channel (14) comprising:

    + a first base color module (22) configured for providing, for each execution cycle, a first list comprising a first base color for each expected color, each first base color of said first list being based on the random number corresponding to the execution cycle;
    + a first generation module (26) configured for selecting, for each execution cycle, the first base color from the first list corresponding to the execution cycle, based on the state signal, so as to provide a selected first base color;

- a second channel (16) comprising:

    + a second base color module (31) configured for providing, for each execution cycle, a second list having a second base color for each expected color, each second base color of said second list being based on the random number corresponding to the execution cycle;
    + a second generation module (34) configured for selecting, for each execution cycle, the second base color from the second list corresponding to the execution cycle, based on the state signal, so as to provide a selected second base color;

- a merging module (18) configured for merging, for each execution cycle, a first output signal comprising the selected first base color and a second output signal comprising the selected second base color so as to obtain the image signal, wherein the image signal comprises the expected color associated to the state of the state signal;
- a transmission module (20) configured for transmitting, for each execution cycle, the image signal to a user interface (6) via a data connection (45).

2. Generation system (4) according to claim 1, wherein the merging module (18) comprises an XOR-operator configured for receiving the first output signal and the second output signal as inputs of the XOR-operator, and for providing the image signal as an output of the XOR-operator.

3. Generation system (4) according to claim 1 or 2, wherein the selected first base color and the selected second base

color are values expressed in binary code.

4. Generation system (4) according to any one of the preceding claims, wherein the first output signal comprises a series of first images defined by a plurality of pixels, at least one pixel of the series of first images preferably comprising the selected first base color, and/or
wherein the second output signal comprises a series of a second images defined by a plurality of pixels, at least one pixel of the series of second images preferably comprising the selected second base color.

5. Generation system (4) according to any one of the preceding claims, wherein the first channel (14) further comprises a first conversion module (30) configured for receiving, from the first generation module (26), a first intermediate signal comprising vector image data comprising the selected first base color, and for converting the first intermediate signal into the first output signal, and/or
wherein the second channel (16) further comprises a second conversion module (38) configured for receiving, from the second generation module (34), a second intermediate signal comprising vector image data comprising the selected second base color, and for converting the second intermediate signal into the second output signal.

6. Generation system (4) according to claim 5, wherein the first channel (14) further comprises at least one first image database (28) comprising first stationary image data relative to the trackside signaling equipment (2), the first generation module (26) being configured for generating the first intermediate signal in function of the first stationary image data and the selected first base color, and/or
wherein the second channel (16) comprises at least one second image database (36) comprising second stationary image data relative to the trackside signaling equipment (2), the second generation module (34) being configured for generating the second intermediate signal in function of the second stationary image data and the selected second base color.

7. Generation system (4) according to claim 5, wherein the first channel (14) further comprises at least one first image database (28) comprising first stationary image data relative to the trackside signaling equipment (2), the first generation module (26) being configured for generating the first intermediate signal in function of the first stationary image data and the selected first base color, and

wherein the second channel (16) comprises at least one second image database (36) comprising second stationary image data relative to the trackside signaling equipment (2), the second generation module (34) being configured for generating the second intermediate signal in function of the second stationary image data and the selected second base color, and
wherein the first stationary image data and the second stationary image data are equivalent.

8. Generation system (4) according to any one of the preceding claims, further comprising at least one base color database (24, 32) comprising indexes corresponding to the random numbers, the base color database (24, 32) comprising, for each index and for each expected color, a corresponding first base color and/or a corresponding second base color.

9. Generation system (4) according to claim 8, wherein, for each index and for each expected color, the corresponding first base color and the corresponding second base color are determined so as to satisfy the following condition: the corresponding first base color merged with the corresponding second base color by the merging module results in the expected color.

10. Generation system (4) according to claim 8 or 9, wherein, for each expected color, the first base color associated to the index equal to N is different from the first base color associated to the index equal to N+1 and to the index equal to N-1, wherein N is a positive integer, and/or
wherein, for each expected color, the second base color associated to the index equal to N is different from the second base color associated to the index equal to N+1 and to the index equal to N-1.

11. Generation system (4) according to any one of the preceding claims, wherein the receiving module (10), the number generator (12), the first and second base color modules (22, 31) and the first and second generation modules (26, 34) are implemented by a first calculator (44), and the merging module (18) is implemented by at least one second calculator (46) distant to the first calculator (44).

12. Generation system (4) according to any one of the preceding claims, wherein the image signal comprises the

expected colors associated to the state of a plurality of devices of the trackside signaling equipment (2).

13. Railway signaling system (1) comprising trackside signaling equipment (2), a generation system (4) and a user interface (6), wherein the generation system (4) is according to any one of the preceding claims.

14. Method for generating an image signal based on a state of trackside signaling equipment (2) of a railway signaling system (1), said state being a state among a plurality of predetermined states of the trackside signaling equipment (2), at least one expected color being associated to each predetermined state, the method comprising:

- a receiving step comprising the reception of a state signal comprising the state of the trackside signaling equipment (2);
- a number generating step comprising the generation of a random number, the generation of the random number defining an execution cycle;
- a first providing step comprising the provision, for each execution cycle, of a first list comprising a first base color for each expected color, each first base color of said first list being based on the random number corresponding to the execution cycle;
- a first selecting step comprising the selection, for each execution cycle, of the first base color from the first list corresponding to the execution cycle, based on the state signal, so as to provide a selected first base color;
- a second providing step comprising the provision, for each execution cycle, of a second list having a second base color for each expected color, each second base color of said second list being based on the random number corresponding to the execution cycle;
- a second selecting step comprising the selection, for each execution cycle, of the second base color from the second list corresponding to the execution cycle, based on the state signal, so as to provide a selected second base color;
- a merging step comprising the merging, for each execution cycle, of a first output signal comprising the selected first base color and a second output signal comprising the selected second base color so as to obtain the image signal, wherein the image signal comprises the expected color associated to the state of the state signal;
- a transmission step comprising the transmission, for each execution cycle, of the image signal to a user interface (6) via a data connection (45).

15. Computer program product comprising software instructions which, when executed by a computer, implement a method according to the preceding claim.

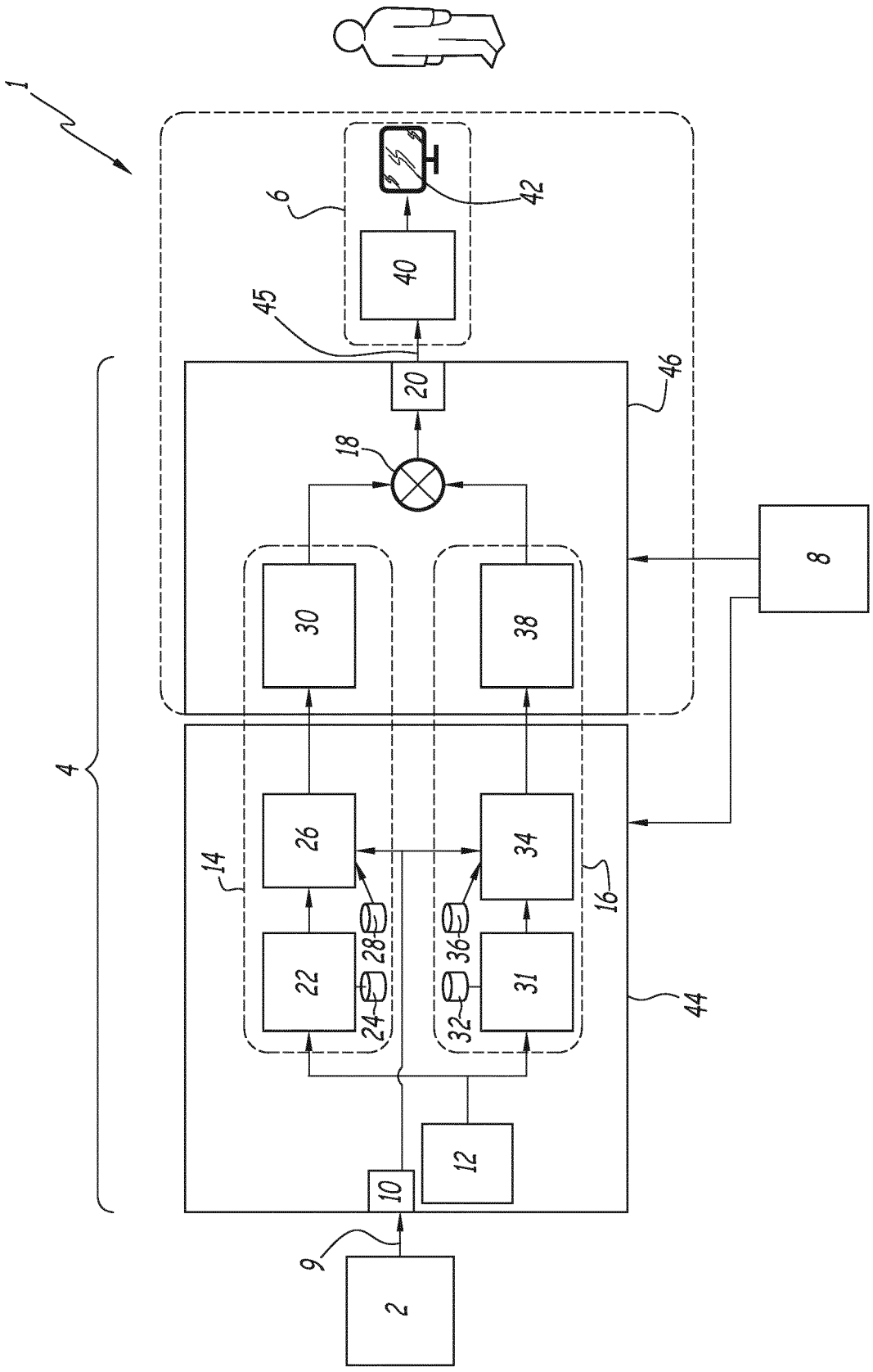

FIG.1

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EUROPEAN SEARCH REPORT

Application Number
EP 21 30 6464

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 March 2022	Pita Priegue, Miguel

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