

(19) **DANMARK**

(10) **DK/EP 3397919 T4**



Patent- og  
Varemærkestyrelsen

(12) **Oversættelse af ændret  
europæisk patentskrift**

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- (51) Int.Cl.: **F 41 G 3/26 (2006.01)** **G 09 B 9/00 (2006.01)** **G 09 B 9/04 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2024-02-26**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om opretholdelse af patentet i ændret form: **2022-08-03**
- (86) Europæisk ansøgning nr.: **16809886.1**
- (86) Europæisk indleveringsdag: **2016-12-16**
- (87) Den europæiske ansøgnings publiceringsdag: **2018-11-07**
- (86) International ansøgning nr.: **EP2016081552**
- (87) Internationalt publikationsnr.: **WO2017114671**
- (30) Prioritet: **2015-12-30 BE 201505852**
- (84) Designerede stater: **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**
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- (54) Benævnelse: **FREMGANGSMÅDE OG ANORDNING TIL TÅRNSIMULATION**
- (56) Fremdragne publikationer:  
**EP-A2- 0 947 797**  
**EP-A2- 2 418 635**  
**FR-A1- 2 420 737**  
**US-A- 4 789 339**



## TURRET SIMULATION METHOD AND DEVICE

### Description

#### 5 Technical field

In a general sense, the invention relates to an immersive simulation method for coaching and training a crew in the use of an armoured vehicle turret. The invention relates in addition to system comprising a turret configured for the implementation of this method.

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#### Technological background

In order to coach and train military personnel in the use of the turrets mounted on to armoured vehicles, it is a known practice to use simulators on a personal computer where  
15 the user is confronted with various scenarios.

It is also a known practice to use the vehicle as such as a simulation space. These simulations referred to as “embedded” simulations provide the ability to adhere as closely as possible to the real conditions on the ground. In addition to their potential for  
20 greater realism, embedded simulations have the advantage that they allow the use of reserve material resources. With respect to armoured vehicles, it is a fact that in times of peace, only a small portion of the fleet of vehicles is operational and used mainly for manoeuvres on the ground, the rest of the vehicles being parked in hangars and depots. Thanks to the embedded simulations, it is possible to exploit these inactive resources for  
25 the purposes of coaching and training at costs that are far more reasonable than those incurred for the acquisition and maintenance of a fleet of hardware - based simulators offering a degree of realism as close as possible to the actual systems.

Document FR 2 420 737 describes a device for the training of the gunner of an  
30 armoured vehicle where the vehicle is used as a simulator. In this device, an image representing the target is projected in the optical sight system of the gunner. By operating the sight joystick, the user can sight and pursue the represented target. In order to optimally reproduce the actual conditions, the device can be equipped with loudspeakers

in order to simulate the sounds of the vehicle. Furthermore, the device is suitable for superposing movements of the target in the sight system that simulate the independent movement of the vehicle on a more or less rugged terrain.

5      Thereafter, a more developed training method for armoured vehicles was disclosed in document EP 0 947 797 A2. In this document, a simulation computer is connected to the central computer of the vehicle and, in simulation mode, the screens of the vehicle show the simulation data processed by the central computer and by the simulation computer as well as the data relating to the functions that are activated by the trainee. In simulation  
10      mode, all the operational and movement related functions of the vehicle, such as those of the engine, direction, armaments, etc, are blocked whereas all the acquisition interfaces of the vehicle remain operational. In this device, it is incumbent only on the simulation computer to take charge of the computation of the new status of the system on the basis of the entries made by the trainee. This has the disadvantage of requiring  
15      that all the operating functions be replicated in the simulation computer.

Document EP 1 715 285 A1, which is critical of this drawback, proposes a solution whereby the simulation computer sends the simulation data to the central computer and the latter calculates the new status of the system.

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However, there remains a drawback both in the case of the device described in document EP 0 947 797 A2 as well as the one in document EP 1 715 285 A1 that the realism of the simulation leaves much to be desired.

25      Document EP 2 418 635 teaches an alternative to the system described in document EP 0 947 797 A2, which is better suited to older armoured vehicles, in particular armoured vehicles which are not equipped with a computer bus system.

Document US 4,789,339 describes a portable training equipment unit that can be  
30      connected to an armoured vehicle so as to make the armoured vehicle serve as interface between the simulation and the crew.

### **Technical problem**

An aim of one aspect of the present invention is to enhance the potential of the realism of an immersive simulation of a turret of an armoured vehicle.

## 5 **General description of the invention**

A first aspect of the invention relates to an immersive simulation method according to Claim 1 for coaching and training a crew in the use of an armoured vehicle turret that produces stimuli for several types of human sensory perceptions. It is assumed that the turret comprises a control computer, as well as acquisition interfaces for commanding equipment units of the turret and rendering interfaces for the presentation of data to the crew, the control computer as well as the acquisition interfaces and the rendering interfaces being connected to each other by means of a computer bus ( or digital bus ). The method comprises the following actions :

- 15 ○ an armoured vehicle turret as described above is provided;
- the control computer is connected to a simulation computer, to which the control computer communicates the status of the turret ;
- the simulation computer produces a virtual environment which is presented at least in part to the crew by means of the rendering interfaces ;
- 20 ○ one or more motorised equipment units of the turret are in operation ; and
- the commands entered by the crew via the acquisition interfaces to the motorised equipment units that are in operation are transmitted to the latter, such that the movements of these equipment units that are brought about by these commands induce in the crew sensations of an optical or auditory nature, and/or of acceleration.
- 25

In the context of the present document, the term “acquisition interface” is used to refer to any device that makes it possible for the crew (or to only a part of the crew) to enter a command or data in the equipment unit of the turret, for example, a button, a wheel, a joystick, a keyboard, a motion sensor, a microphone with speech recognition, etc. The term “rendering interface” is used to refer to any device by which the turret (or one of its components) can communicate in the reverse direction, that is to say, to the crew. Examples of rendering interfaces are screens, indicator lights, system status signals,

loudspeakers, acoustic signalers, etc. It should be noted that certain interfaces, that are “combined interfaces”, are both acquisition interfaces as well as rendering interfaces within the meaning of this document, for example touch screens, force-feedback joysticks, etc.

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The term “connected” means, in the context of this document, being “communicatively linked”. The connection may be done in wired or wireless mode, unless it is otherwise stated in the context.

10 The term “equipment unit ” is used to refer to any device or assembly of devices being part of the turret and which carries out a certain function and, depending on the case, related functions. A “motorised equipment unit ” is an equipment unit that is actuated by a motor. The motor may either form part of the motorised equipment unit or be separate. Unless specifically mentioned otherwise, the term “ equipment unit ” may  
15 refer to either a motorised or non-motorised equipment unit.

Thanks to the invention, it is nowadays possible to subject turret crews to simulations having an extremely high level of realism, which previously could not have been achieved other than by manoeuvres on the ground. However, such manoeuvres require  
20 an enormous amount of time, people, equipment, and space and are not without consequences on the environment or on the lifespan of the equipment used for the training. The invention thus makes it possible not only to reduce by a significant degree the costs of training on a per crew or per person basis, but also to significantly improve the level of control of the weapon. An additional advantage of the invention lies in the  
25 fact that there is no need for the turret to undergo any modification of its settings that are necessary for normal operation ( outside of the simulation ) which averts any influence of the simulation mode on the normal operation mode.

It will be appreciated that, in a manner quite contrary to the teaching of documents EP  
30 0 947 797 A2 and EP 1 715 285 A1, at least one motorised equipment unit of the turret, preferably several, and even more preferably all the motorised equipment units, are in operation during the simulation and thus respond through movements to the commands that concern them which are input by the crew. The movements, in their turn, produce

optical (visual) effects, acoustic (auditory) effects and / or acceleration effects as well as, among the members of the crew, the sensations that are related thereto. The realism of the simulation is significantly improved. Preferably, the effects induced are a combination of several of the above-mentioned effects, for example, a combination of  
5 optical and auditory effects, a combination of auditory and acceleration effects, a combination of optical, acoustic, and acceleration effects. The acceleration effects comprise, in particular, vibrations.

Preferably, one of the motorised equipment units of the turret that are in operation in  
10 simulation mode or the plurality of them comprise one or more of the following : the cannon elevation mechanism, the sight system, the ammunition rack, the turret rotation system, the turret stabilisation system, and the smoke extraction system.

Although it is so preferred in order to enhance the realism of the simulation, the  
15 motorised equipment units of the turret are not necessarily all in operation during the simulation. For example, the azimuthal rotation mechanism for the turret could be blocked ( for reasons related to space, security, or other factors ). In simulation mode, the turret may thus comprise equipment units ( motorised or non - motorised ) that are deactivated. However, the deactivated equipment units are preferably presented as  
20 operational to the crew ( except when simulating failure of an equipment unit ). According to a particularly realistic embodiment of the simulation, the turret is fully operational, that is to say, all the equipment units ( whether or not motorised ) are in operation.

25 According to one embodiment of the simulation method, commands entered by the crew via the acquisition interfaces to equipment units that seem to be in operation but are in fact deactivated are transmitted to the simulation computer that generates a simulated reaction of the equipment units to these commands. The simulated reaction is presented to the crew by means of the rendering interfaces.

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The turret may comprise sensors that provide data pertaining to the exterior of the turret ( for example a camera, a lidar, a radar, a thermometer, atmospheric sensors, satellite positioning system, etc ) in case of normal operation of the turret. When the turret is used

in simulation mode, the simulation computer provides data pertaining to the virtual environment that replace the data from such sensors. This does not mean that these sensors are necessarily turned off in simulation mode. For example, in simulation mode, the control computer and/or the simulation computer can be configured to ignore or  
5 overwrite the data originating from sensors that have not been turned off.

The turret may also comprise sensors that operate normally in simulation mode and the data of which are not irregular compared to the normal operation of the turret. In simulation mode, the data from sensors that operate normally may be transmitted to the  
10 simulation computer in the context of the communication of the status of the turret such that the simulation computer is able to take the same into account for the simulation.

Preferably, if there are sensors that, in simulation mode, produce errors or irregular data on account of the deactivation of one or more equipment units, the simulation computer  
15 provides simulated data which replace the errors or irregular data from these sensors.

According to the invention, movements of the armoured vehicle bearing the turret in the virtual environment are simulated by means of a simulator for the driver station of the armoured vehicle, the simulator for the driver station being connected to the simulation  
20 computer. According to the invention, the simulator for the driver station is separate from the armoured vehicle. The simulator for the driver station may be a replica (that is more or less realistic) of the driver station of the armoured vehicle, or in a simpler implementation, a PC (personal computer) or a simplified interface that provides the ability to monitor the progress of the armoured vehicle. In this configuration, the  
25 simulation method comprises, on the one hand, an embedded simulation component for the crew of the turret and, on the other hand, a simulation component on a simulation station.

According to an advantageous embodiment of the method, the virtual environment  
30 generated by the simulation computer comprises an avatar of the turret and/or of the armoured vehicle, which is piloted, during the simulation, by the crew of the turret and/or of the armoured vehicle.



The simulation computer may comprise or be connected to a network of simulation computers.

5 According to an embodiment of the simulation method, at least one other armoured vehicle turret is provided and the simulation computer is connected to the control computer of the at least one other turret. Preferably, all the connected turrets share the same virtual environment and the same scenario. It is therefore possible to simulate exercises involving multiple armoured vehicles and their turrets. The crews are thus able to train to act in formation.

10

The simulation computer may be connected to one or more instructor stations where the activities of the turret are monitored and from where the course of the simulation may be created, influenced, and /or recorded. In case of networked simulation, each turret or armoured vehicle may have its own dedicated instructor. If necessary, the recording of  
15 the simulation may be used during a debriefing of the crew. In the context of one such debriefing, the recording ( the “film”) of the simulation may be reproduced in front of the crew. The avatar of the turret makes it possible in this context to represent ( to view ) the actions carried out by the crew, with the instructor being able to comment thereupon.

20 According to a preferred embodiment of the simulation method, the rendering interfaces comprise screens, which, in case of normal operation of the turret, display the images from the sight cameras, but which in the simulation method display images of the virtual environment, which are generated taking into account the position and orientation of the sight cameras in the virtual environment.

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The virtual environment produced by the simulation computer may comprise a geographical environment, meteorological conditions and, possibly, entities or avatars denoting friendly, enemy or neutral presences ( for example other armoured vehicles ). The avatars can be piloted by other participants in a networked exercise or by the  
30 simulation computer.

A second aspect of the invention relates to a simulation system according to Claim 11 comprising an armoured vehicle turret that is suitable for being used in the simulation

- method described above. One such turret comprises a control computer, equipment units, of which one or more are motorised, as well as acquisition interfaces for commanding the equipment units and at least a rendering interface for the presentation of data to the crew. The control computer is configured so as to place the turret,
- 5 following a triggering event, in a simulation mode in which :
- the control computer connects to a simulation computer, and if the connection is successfully established, communicates the status of the turret to the simulation computer ;
  - the rendering interfaces show the crew data relating to a virtual environment ;
  - 10 ○ one or more motorised equipment units of the turret are in operation ; and
  - the commands entered by the crew via the acquisition interfaces to the motorised equipment units that are in operation are transmitted to the latter, such that the movements of these equipment units that are brought about by these commands produce effects of an optical or auditory nature, and/or of
  - 15 acceleration.

Some examples of equipment units being in operation in simulation mode have been cited above.

- 20 The triggering event that activates the simulation mode may be the detection of a connection between the control computer and an interface box or between the control computer and a simulation computer. Preferably, the control computer verifies the authenticity of the interface box of the simulation computer before placing the turret in simulation mode. The control computer can be configured so as to place the turret,
- 25 following the detection of a disconnection of the interface box or of the simulation computer, back into its normal operating mode.

- According to the invention, the simulation system comprises in addition a simulation computer for producing the virtual environment, and a simulator for the driver station of
- 30 the armoured vehicle bearing the turret in the virtual environment, the simulator for the driver station being located apart from the armoured vehicle ( and the turret ) and connected to the simulation computer.

**Brief description of the drawings**

Other particularities and features of the invention will emerge from the detailed description of some advantageous embodiments presented below, by way of illustration only, with reference being made to the attached drawings that show :

- 5 Fig. 1: A diagram illustrating the communication system of a turret that is connected to a simulation computer ;
- Fig. 2: A very simplified diagram showing several turrets, driving station simulators and instructor station simulators that are network connected ;
- 10 Fig. 3: A more detailed diagram of an example of the network shown in Figure 2.

**Detailed description of embodiments of the invention**

The turret simulators known in the state of the art all have certain drawbacks, because the immersion of the crew in the scenario of the exercise is not complete. The simulators on PC have the disadvantage that the members of the crew do not work in the conditions that prevail within a turret and therefore cannot familiarise themselves at the time of the simulation with the particularities that are involved in the actual handling of the equipment of the turret. The existing embedded simulators, on the other hand, offer a level of realism that leaves much to be desired. Crew members are therefore unable to completely immerse themselves in the conditions of narrow confinement and stress encountered in the event of a real conflict, given that the inadequacies of the current simulations leave too much room for imagination.

25 The embodiment of the invention that is subsequently discussed relates to a simulation system and method for coaching and training a crew in the use of a turret mounted on to an armoured vehicle.

In order to be able to exploit inactive material resources and attain a level of realism that is unmatched to this day, use is made of a real turret that is in operation and that is not a replica. The turret is connected to a simulation computer, which provides a virtual reality in which the exercise takes place and the crew pilots an avatar of the armoured vehicle with its turret. While the turret becomes the interface with this virtual reality for the crew

of the turret ( typically a commander and a gunner ), the driver of the armoured vehicle bearing the turret takes up position on a separate simulation station, from where he commands the functions specific to the vehicle, while also being an actor in the simulation exercise by interacting with the crew members of the turret. During a  
5 simulation, the crew find themselves confined within the turret and are exposed to stimuli which result, on the one hand, from the presentation of the virtual environment and, on the other hand, from the interaction with the real equipment units in the turret, some of which, preferably most, and possibly all of which, are in operation. In the context of this illustration of the invention, it will be assumed that the motorised  
10 equipment units in operation comprise, in particular : the cannon elevation mechanism, the sight system, the ammunition rack, and the smoke extraction system. As they are in operation, the manipulation of these equipment units involves no difference for the crew as compared to the normal operation of the turret. In particular, these equipment units produce the usual noises and vibrations that the crew can therefore feel and which  
15 contribute to the realism of the exercise.

Figure 1 diagrammatically shows how the turret 10 is connected to the simulation computer 12. The passage of the turret 10 from the normal operating mode to a  
20 “simulator” mode is done by means of an interface box 14, which is connected to the shared communication system 16 ( to the computer bus ) of the turret 10 and which links the latter to the simulation computer 12.

In the example illustrated in Figure 1, the interface box 14, or SEI (“ Simulator Embedded Interface ”), is connected to the control computer 18 (TNC, “turret network  
25 controller”) via the rotating collector 20 of the turret 10. The simulation computer 12 can thus “listen” to all the messages that are exchanged on the shared communication system 16 and inject therein its own messages via the control computer 18. The interface box 14 is also connected to the video bus 22 of the turret 10 by means of a video multiplexer 24 (VMC, “video matrix controller”). This broadband video connection is  
30 used by the simulation computer to inject images of the virtual environment, intended to replace the images provided by the cameras 26, 28, 30 of the turret 10.

The turret 10 comprises various equipment units that are controlled or monitored by the

control computer 18, acquisition interfaces and rendering interfaces. The acquisition interfaces comprise, in the example shown in Figure 1, all the buttons, wheels, etc, of the commander station 32 (CDR, "commander") and the gunner station 34 (GNR, "gunner"), including the respective control joysticks for the turret 36 and 38. The rendering interfaces comprise, in this example, in particular the screens 40, 42 at the stations 32, 34 of the commander, and the gunner respectively. The equipment units of the turret 10 comprise, in the example shown, the elevation mechanism for the cannon 44 (ED, "elevation drive"), the azimuthal rotation mechanism for the cannon 46 (AD, "azimuth drive"), both coupled to a power control system 45 (PCS, "power control system"), an ammunition rack controller system 48 (ARC, "ammunition rack control"), a missile guidance system 50 (MGU, "missile guidance unit"), a power distribution system 52 (PDS, "power distribution system"), one or more equipment units provided by the customer 54 (CFE, "customer furnished equipment"), as well as various sensors 56, 58, 60, 26, 28, 30 which may be connected to the computer bus 16 or directly to the control computer 18.

In the normal operation of the turret 10, the screens 40, 42 are used to display the images provided by the different cameras, which comprise the camera 28 of the sight system of the commander (CSS, "commander sight system"), the camera 30 of the sight system of the gunner (GSS, "gunner sight system") and one or more cameras for close observation 26 (COS, "close observation system"). The video data flow over the video bus 22 under the control of the video multiplexer 24, which is itself controlled by the control computer 18 of the turret 10.

The sensors, which, in case of normal operation of the turret 10, provide data pertaining to the external environment of the turret, comprise, among others, the cameras 26, 28, 30. When the turret 10 is used in simulation mode, the simulation computer 12 provides images of the virtual environment that replace the images from these cameras 26, 28, 30. To this end, the simulation computer produces computer-generated images of the virtual environment while at the same time taking into account the position and orientation of the turret 10 on the simulation terrain and the position and orientation of the cameras in the frame of reference of the turret 10. The videos thus obtained are encoded in the video format used by the turret and put on the video bus 22 of the turret

via the video multiplexer 24. In simulation mode, the control computer 18, by making use of the video multiplexer 24, switches the different videos provided by the simulation computer 12 on to the channels "listened to" by the different screens 40, 42 and by the sight systems CSS/GSS, so as to replace the videos provided by the cameras 26, 28, 30.

5 The cameras 26, 28, 30 can be turned off by the control computer 18 in simulation mode. However, if they remain active, the videos they produce are ignored.

With regard to the other sensors that provide data pertaining to the exterior of the turret 10, their data are also replaced by data relating to the virtual environment, which are produced by the simulation computer 12. Like the cameras 26, 28, 30, these sensors can be switched off in simulation mode. If some of them remain active in simulation mode, the control computer 18 prevents the data originating from these sensors from being taken into account by an equipment unit of the turret and replaces them with the respective data from the simulation computer 12.

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The turret 10 comprises other sensors that operate normally in simulation mode, because the physical quantities that they monitor are not dependent upon the external environment. Such sensors may be found in particular in the acquisition interfaces and in certain equipment units (either motorised or not), for example, to determine the position of a moving part, the temperature at a certain place, the level of a fluid, etc. In simulation mode, the data from these sensors are transmitted to the simulation computer 12 that takes the same into account for the simulation. For example, thanks to such data, the simulation computer 12 is informed of the status of the turret 10, including the position and orientation of the turret 10, the elevation of the cannon 62 as well as the position and orientation of the cameras 26, 28, 30.

20  
25

The simulation mode is automatically triggered by the control computer 18 when it detects that the interface box 14 is connected. The switching over from the normal operating mode to the simulator mode, and vice versa, is therefore done very quickly by virtue of connecting or disconnecting the interface box 14. In switching over into simulation mode, the control computer tries to connect to the simulation computer 12. Once the connection is established, it is synchronised with the simulation computer 12. It also deactivates all the equipment units that are not supposed to be operating in

30

simulation mode. In particular, for safety reasons, the control computer 18 inhibits firing. However, as described above, some motorised equipment units, in particular the cannon elevation mechanism, the sight system, the ammunition rack, and the smoke extraction system, remain or are placed in operation by the control computer 18. It should be noted that the deactivation or activation of certain equipment units may depend on the type of armament of the turret. For example, a large calibre cannon is typically loaded by means of a motorised rack while a medium calibre cannon comprises a passive ( non motorised ) rack. Preferably a motorised ammunition rack is in operation during the simulation, even if it does not carry any ammunition ( for the simulation use can also be made of dummy ammunition ). A medium calibre cannon can be cycled empty during the simulation. Lastly, the control computer 18 modifies the configuration settings of the turret so as to take control over the communication from or to deactivated equipment units, divert the communication to the simulation computer 12, respectively.

As a consequence thereof, the crew members of the turret are confronted with a virtual reality that comprises realistic external conditions on the ground as well as atmospheric / weather conditions ( visibility, wind, rain,... ). In addition, the turret is presented to the crew in its operational state. The equipment units react, or seem to react, to the actions of the crew as if the turret were actually on the virtual terrain. In particular, the motorised equipment units that are in operation produce the stimuli, among others the noises, the vibrations, and the visual impressions that are expected by the crew in actuating these equipment units. For example, once the sight system is locked on a ( virtual ) target, it will force the orientation system of the cannon to follow the target. If the vehicle bearing the turret is ( virtually ) in motion, the orientation system of the cannon will compensate for the ( virtual ) movement of the vehicle with a real movement, which is perceptible by the crew.

For even greater realism, it is possible to use additional rendering interfaces, which are not included in the equipment units of the turret. For example it would be possible to mount the turret on to a table that generates vibrations simulating the movement of the turret in the virtual environment, or vibrations resulting from the virtual weather conditions, etc.

Figures 2 and 3 show several turrets 10a, 10b, 10c, 10d ; driver station simulators 64a, 64b, 64c, 64d and instructor stations 66a, 66b, 66c, 66d that are network connected. The simulation computer or the simulation computer network is not shown in Figure 2, but a possible architecture for the system is illustrated in Figure 3. Each turret is associated with a driver station simulator, from which the avatar of the armoured vehicle is piloted in the virtual reality generated by the simulation computer(s). The actions of the crew of each armoured vehicle, that is to say, in the example shown, of the commander and the gunner installed in the turret and of the driver (DRV, “driver”) installed in the associated simulator, can be monitored by an instructor (INST, “instructor”) from the respective instructor station. The instructor also has the opportunity to influence the course of the simulation, for example, by giving orders to the crew, triggering actions of the enemy, causing failures, etc.

All the turrets, simulators and instructor stations can share the same virtual environment and the same scenario. In this way, it is possible to conduct virtual manoeuvres having an extremely high level of realism. The virtual environment comprises a terrain (including therein the relevant wildlife, flora and possible constructed structures), meteorological conditions (wind, precipitation, visibility, etc.), the avatars of the armoured vehicles and possibly other avatars controlled by artificial intelligence.

Figure 3 shows a possible network architecture. A master simulation computer, for example, the one used by the principal instructor INST 1, generates the parameters that define a virtual environment shared by all the members of the network. The simulation-related computations are distributed over several computers that are synchronised with each other. Thus, each driver station simulator comprises a dedicated computer. In the illustrated network, there is also a simulation computer for each commander station and for each gunner station. In this manner, in particular the computations for rendering the part of the virtual environment seen by each member of the crew can be distributed in an efficient manner, and a level of visual realism can be attained. However, it should be noted that it is possible to consolidate the tasks of multiple computers in one single computer if the computing power of the latter is sufficient.

While specific embodiments have just been described in detail, the person skilled in the



art will appreciate that it is possible for various modifications and alternatives to these embodiments to be developed in the light of the overall teaching provided by this present disclosure of the invention. As a consequence thereof, the specific methods and/or arrangements described therein are thus supposed to be given only by way of illustration, 5 with no intention to limit the scope of the invention, which is determined by the extent of the related claims.

## Patentkrav

1. Immersiv simuleringsfremgangsmåde til uddannelse og træning af en besætning i brugen af et tårn (10) i et pansret køretøj, hvilken fremgangsmåde omfatter de følgende trin:
- 5 der tilvejebringes et tårn (10) til et pansret køretøj, hvilket tårn (10) omfatter en kontrolcomputer (18) såvel som indsamlingsgrænseflader (36, 38) til styring af udstyret i tårnet (10) og gengivelsesgrænseflader (40, 42) til fremlæggelse af data til besætningen, idet kontrolcomputeren og indsamlingsgrænsefladerne og gengivelsesgrænsefladerne er forbundet med hinanden ved hjælp af en computerbus (16):
- 10 kontrolcomputeren er forbundet til en simuleringscomputer (12), til hvilken kontrolcomputeren giver meddelelse om tårnets tilstand
- simuleringscomputeren producerer et virtuelt miljø, der i det mindste delvist fremlægges for besætningen ved hjælp af gengivelsesgrænsefladerne
- 20 ét eller flere motoriserede udstyr i tårnet er i driftstilstand, og
- de kommandoer, der indtastes af besætningen via indsamlingsgrænsefladerne til de motoriserede udstyr i driftstilstand, sendes til dem, idet disse udstyrs bevægelser, der forårsages af disse kommandoer, frembringer optiske og/eller auditive fornemmelser og/eller accelerationsfornemmelser for besætningen, hvilken fremgangsmåde i øvrigt omfatter simulering af bevægelserne af det pansrede køretøj, der bærer tårnet, i det virtuelle miljø gennem en simulator (64a-64d) af førerstationen for det pansrede køretøj, idet simulatoren af førerstationen befinder sig væk fra det pansrede køretøj og er forbundet til simuleringscomputeren.
- 30
- 35
2. Fremgangsmåde ifølge krav 1, hvorved de af besætningen via indsamlingsgrænsefladerne indtastede kommandoer til udstyr, der lader til at være i

driftstilstand, men som faktisk er deaktiveret, sendes til  
simuleringscomputeren, som genererer en simuleret reaktion  
fra udstyret på disse kommandoer, og  
den simulerede reaktion fremlægges for besætningen gennem  
5 gengivelsesgrænsefladerne.

3. Fremgangsmåde ifølge krav 1 eller 2, hvorved  
simuleringscomputeren tilvejebringer virtuelle miljødata,  
der erstatter data fra sensorer, som i tilfælde af normal  
10 drift af tårnet tilvejebringer data om det ydre af tårnet.

4. Fremgangsmåde ifølge et hvilket som helst af kravene  
1 til 3, hvorved data fra sensorer, der fungerer normalt,  
sendes til simuleringscomputeren som et led i meddelelsen  
15 om tårnets tilstand.

5. Fremgangsmåde ifølge et hvilket som helst af kravene  
1 til 4, hvorved simuleringscomputeren tilvejebringer  
simulerede data, der erstatter data fra sensorer, som  
20 producerer fejl eller uregelmæssige data på grund af  
deaktivering af ét eller flere udstyr.

6. Fremgangsmåde ifølge et hvilket som helst af kravene  
1 til 5, hvorved simuleringscomputeren omfatter eller er  
25 forbundet til et netværk af simuleringscomputere.

7. Fremgangsmåde ifølge et hvilket som helst af kravene  
1 til 6, hvorved der tilvejebringes mindst ét andet tårn  
til et pansret køretøj, og simuleringscomputeren er  
30 forbundet til computeren til kontrol af det mindst ene  
andet tårn, og hvorved alle tårnene deler det samme  
virtuelle miljø.

8. Fremgangsmåde ifølge et hvilket som helst af kravene  
35 1 til 7, hvorved simuleringscomputeren er forbundet til  
mindst én instruktørstation (66a-66d), hvor tårnenes  
aktiviteter overvåges, og hvorfra simuleringens forløb kan  
påvirkes.

9. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 8, hvorved gengivelsesgrænsefladerne omfatter skærme, der ved normal drift af tårnet viser billederne fra sigtekameraer (28, 30), men som i 5  
simuleringsfremgangsmåden viser billeder af det virtuelle miljø, der genereres under hensyntagen til sigtekameraernes placering og orientering i det virtuelle miljø.

10

10. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 9, hvorved det virtuelle miljø, der produceres af 10  
simuleringscomputeren, omfatter geografisk terræn og meteorologiske forhold.

15

11. Simuleringsystem, der omfatter:

a) et tårn (10) for pansret køretøj, hvilket tårn omfatter en kontrolcomputer (18), udstyr, hvoraf ét eller flere er motoriserede, såvel som indsamlingsgrænseflader (36, 38) 20  
til styring af udstyrene og gengivelsesgrænseflader (40, 42) til fremlæggelse af data til besætningen og en computerbus (16), idet kontrolcomputeren og indsamlingsgrænsefladerne og gengivelsesgrænsefladerne er forbundet med hinanden ved hjælp af computerbussen, og 25  
idet kontrolcomputeren er konfigureret således, at tårnet som følge af en udløsende hændelse bringes i en simuleringstilstand, hvori kontrolcomputeren forbindes til en simuleringscomputer (12) og, såfremt det lykkes at etablere forbindelsen, 30  
giver simuleringscomputeren meddelelse om tårnets tilstand gengivelsesgrænsefladerne fremlægger data om et virtuelt miljø til besætningen  
ét eller flere af de motoriserede udstyr i tårnet befinder sig i driftstilstand, og  
35 de kommandoer, der indtastes af besætningen via indsamlingsgrænsefladerne til de motoriserede udstyr i driftstilstand, sendes til dem, således at disse udstyrs bevægelser, der forårsages af disse kommandoer,

- frembringer optiske og/eller auditive fornemmelser og/eller accelerationsfornemmelser
- b) en simuleringscomputer (12), der er konfigureret til at producere det virtuelle miljø, og
- 5 c) en simulator (64a-64d) af førerstationen for det pansrede køretøj, der bærer tårnet, i det virtuelle miljø, idet simulatoren er placeret væk fra det pansrede køretøj og er forbundet til simuleringscomputeren.
- 10 12. Simuleringssystem ifølge krav 11, hvori det ene eller de flere motoriserede udstyr i tårnet, der befinder sig i driftstilstand i simuleringstilstanden, omfatter én eller flere af følgende: mekanismen (44) til løftning af kanonen (62), sigtesystemet (CSS, GSS), ammunitionsholderen (48),
- 15 tårnrotationssystemet, tårnstabiliseringssystemet og røgudsugningssystemet.
13. Simuleringssystem ifølge krav 11 eller 12, hvori den hændelse, der udløser simuleringstilstanden, er
- 20 detektering af en forbindelse mellem kontrolcomputeren og en interfaceboks eller mellem kontrolcomputeren og en simuleringscomputer.
14. Simuleringssystem ifølge krav 13, hvori
- 25 kontrolcomputeren er konfigureret således, at tårnet efter detektering af en frakobling af interfaceboksen eller simuleringscomputeren, bringes i den normale driftstilstand.

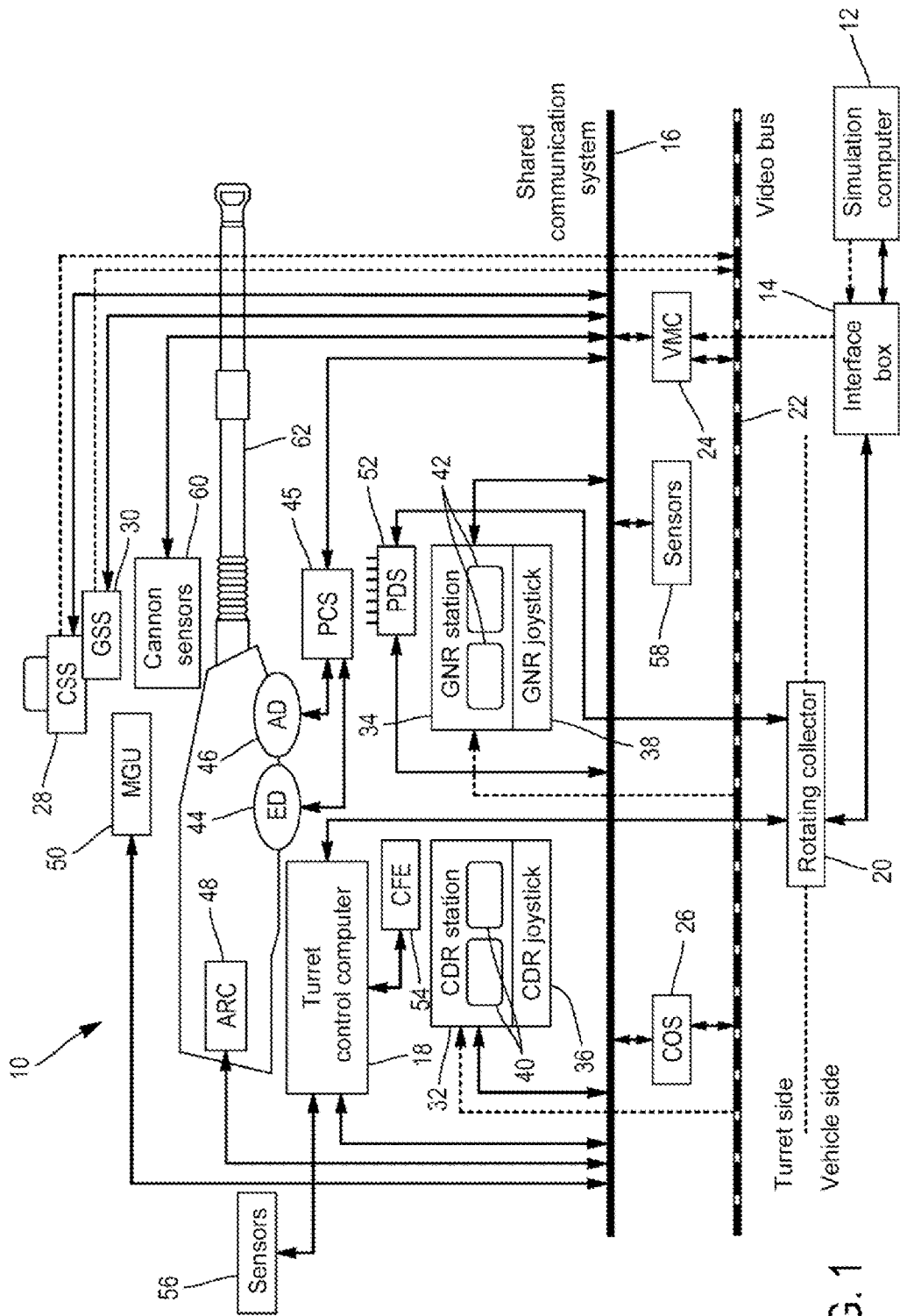


FIG. 1

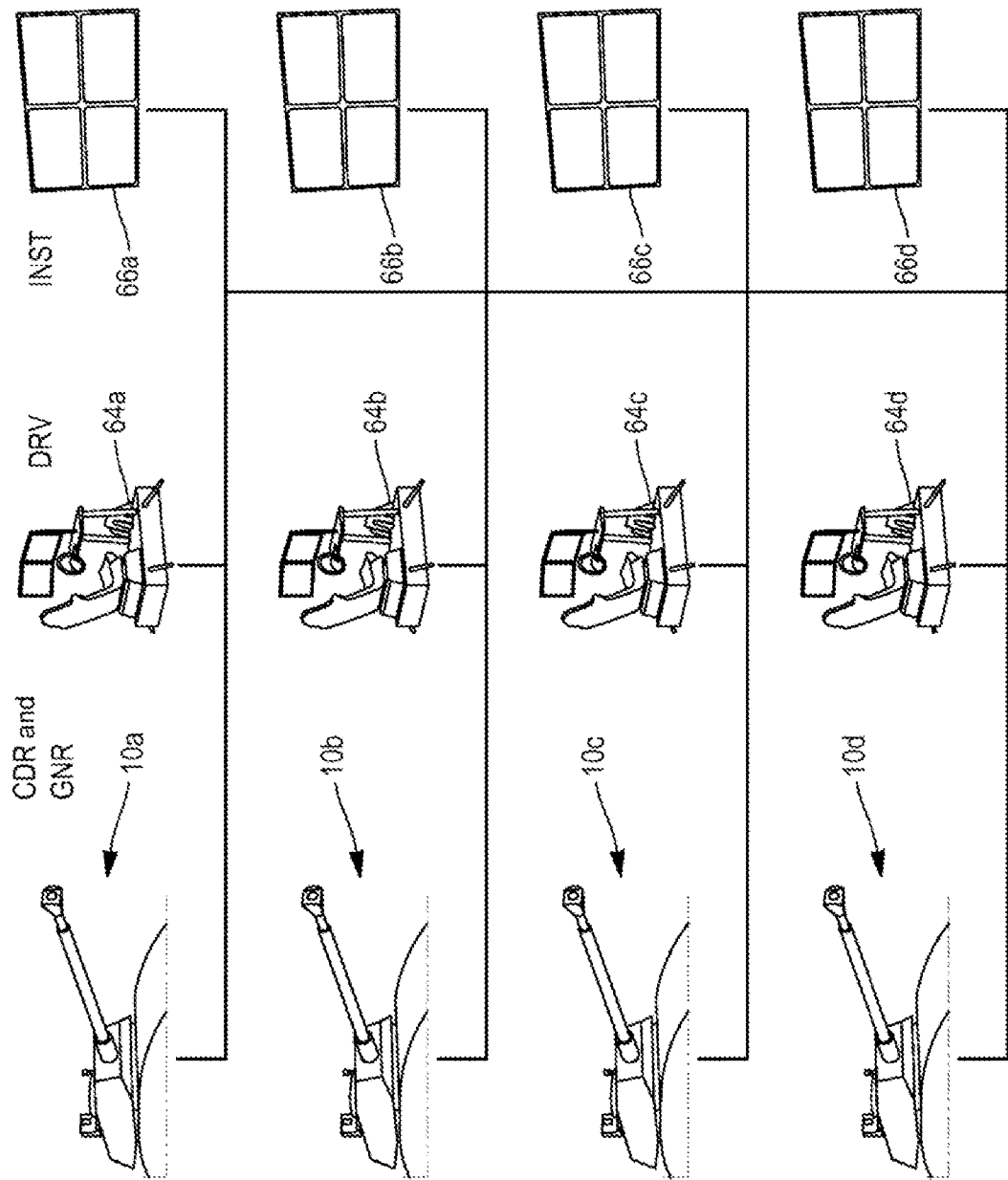


FIG. 2

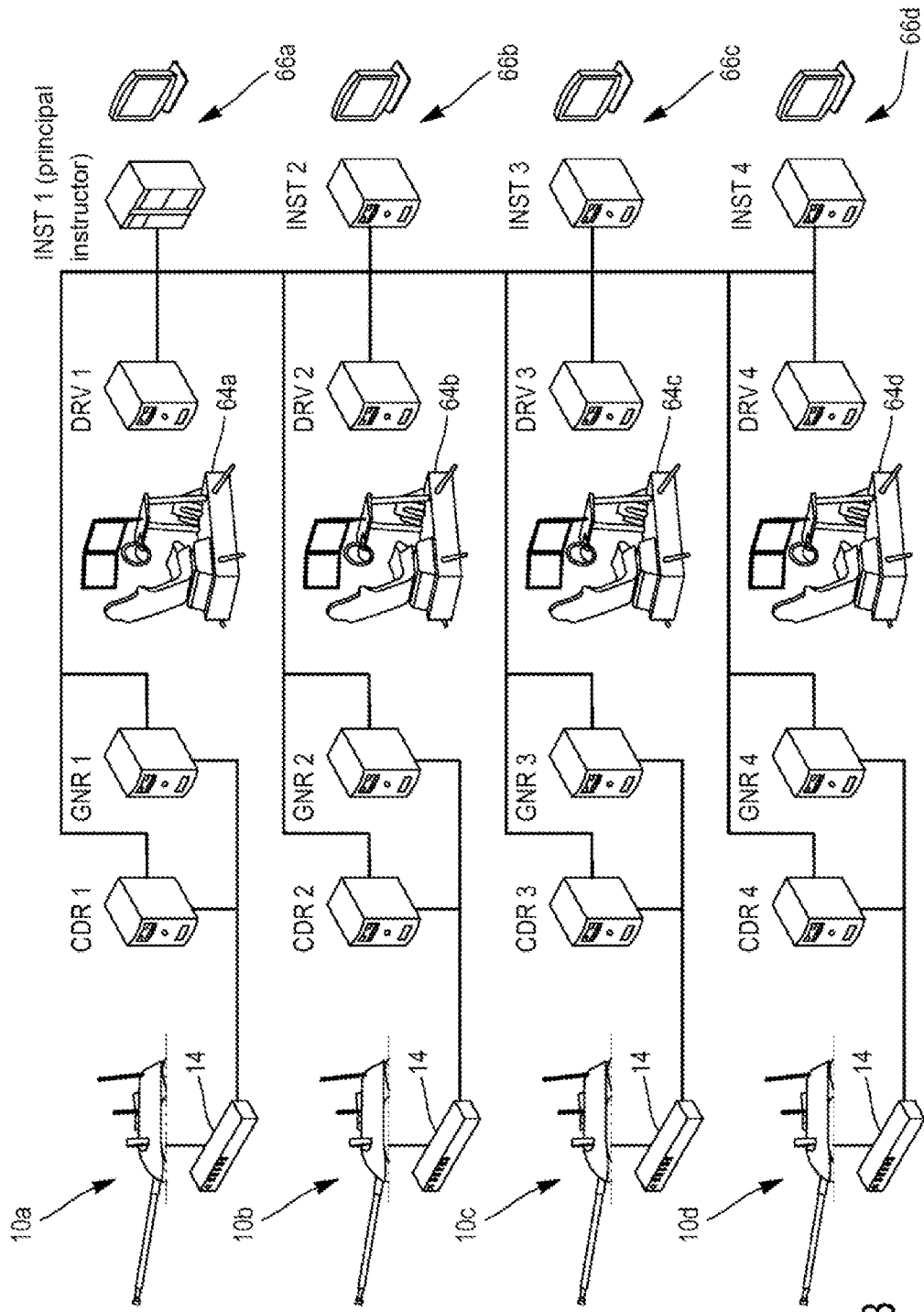


FIG. 3