Title: APPARATUS AND SYSTEM FOR SIMULATING NAVIGATION SIGNAL IN JAMMING ENVIRONMENT

Abstract: A navigation signal simulation apparatus in a jamming environment according to the present invention includes an antenna for receiving a navigation signal of a navigation satellite, an interference signal generation unit for generating an interference signal to limit a normal reception of the navigation signal, and a navigation signal synthesis unit for synthesizing the navigation signal and the interference signal and outputting the synthesized signal to an antenna input port of a satellite navigation receiver. Accordingly, an interference signal and a navigation signal can be reliably simulated using a simple construction when they enter an antenna at the same time.
Description

Title of Invention: APPARATUS AND SYSTEM FOR SIMULATING NAVIGATION SIGNAL IN JAMMING ENVIRONMENT

Technical Field

[1] The present invention relates to an apparatus and system for simulating a navigation signal in a jamming environment, and more particularly, to an apparatus and system for simulating a navigation signal in a jamming environment, which are capable of simulating a navigation signal, exposed to a jamming environment, using cheap equipment without a legal problem and evaluating the performance of a satellite navigation receiver and a satellite navigation jammer in a dynamically operated environment.

[2]

Background Art

[3] Satellite navigation technology, such as a Global Positioning System (GPS), is being actively used in civilian and military purposes as well as vehicle navigation and is thus closely connected with real life. The satellite navigation technology covers a wide area of applications, but is very vulnerable to external Electromagnetic Interference (EMI) signals or electric wave interference signals because signal systems are open and reception power is a receiver noise level or less. Accordingly, technology for dealing GPS electric wave interference and technology in various environments for electric wave interference test technology are being developed in order to overcome the above disadvantages.

[4] In order to perform a GPS EMI signal test, an electric wave interference signal test, or an electric wave interference signal correspondence test, there are known a method of installing and using an outdoor GPS electric wave interference signal generation apparatus, a method of using an electric wave interference simulator in a laboratory, and a method of constructing an expensive GPS signal simulation environment in an anechoic chamber facility. The above methods, however, have disadvantages in that illegal electric waves are transmitted, expensive equipment has to be used, and an environment cannot be dynamically simulated.

[5]

Disclosure of Invention

Technical Problem

[6] Accordingly, the present invention has been made in view of the above problems,
and it is an object of the present invention to provide an apparatus and system for simulating a navigation signal in a jamming environment, which are capable of simulating a navigation signal, exposed to a jamming environment, using cheap equipment without a legal problem and evaluating the performance of a satellite navigation receiver and a satellite navigation jammer in a dynamically operated environment.

The technical objects to be achieved by the present invention are not limited to the above-described objects and other technical objects that have not been described above will become evident to those skilled in the art from the following description.

Solution to Problem

To achieve the above object, a navigation signal simulation apparatus in a jamming environment according to an embodiment of the present invention may include an antenna for receiving the navigation signal of a navigation satellite, an interference signal generation unit for generating an interference signal to limit the normal reception of the navigation signal, and a navigation signal synthesis unit for synthesizing the navigation signal and the interference signal and outputting the synthesized signal to the antenna input port of a satellite navigation receiver.

The navigation signal simulation apparatus may further include a navigation signal branching unit for branching the received navigation signal into a first navigation signal transferred to the interference signal generation unit and a second navigation signal transferred to the navigation signal synthesis unit. The interference signal generation unit may receive the first navigation signal and uses the first navigation signal to generate the interference signal. The navigation signal synthesis unit may synthesize the second navigation signal and the interference signal.

Here, the antenna may include a plurality of lower antennas, and the navigation signal branching unit may branch navigation signals of one of the respective lower antennas.

Furthermore, the interference signal generation unit may include a jamming signal reception unit for receiving a jamming signal which is in a step before the radiation of the antenna from a satellite navigation jammer as the interference signal.

The interference signal generation unit may further include a signal delay unit for generating a delay signal of the first navigation signal as the interference signal.

The first navigation signal may include the navigation signals of a plurality of the navigation satellites. The signal delay unit may include a satellite selection unit for separating the first navigation signal into the navigation signals of the respective navigation satellites and selecting the navigation signal of a target navigation satellite,
a time delay unit for delaying the time of the selected navigation signal, and a delay
synthesis unit for synthesizing the time-delayed navigation signal and unselected
navigation signals of the separated navigation signals and outputting the synthesized
navigation signal.

[15] The time delay unit may include a lower time delay unit corresponding to each of the
navigation satellites.

[16] The interference signal generation unit may further include a jamming signal
reception unit for receiving a jamming signal which is in a step before the radiation of
the antenna from a satellite navigation jammer as the interference signal, a signal delay
unit for generating a delay signal of the first navigation signal as the interference
signal, and an interference signal selection unit for selecting at least one of the delay
signal and the jamming signal and outputting the selected signal to the signal synthesis
unit.

[17] Furthermore, the satellite navigation receiver may include a plurality of antenna input
ports. The antenna may include lower antennas having the same number as the number
of antenna input ports. The interference signal generation unit may generate the in-
terference signal having the same number as the number of antenna input ports. The
signal synthesis unit may synthesize the interference signals and the navigation signals
of the respective lower antennas.

[18] Here, the interference signal generation unit may include a signal generation unit for
generating the interference signals, a channel distributor for distributing the generated
interference signals into channels of the respective antenna input ports, and an angle-
of-arrival simulation unit for modulating at least one of an amplitude and phase of each
of the distributed interference signals and outputting the modulated signal.

[19] Here, the antenna may be the antenna of the satellite navigation receiver.

[20] Furthermore, the signal generation unit may be a jamming signal reception unit for
receiving a jamming signal which is in a step before the radiation of the antenna from
the satellite navigation jammer as the interference signal.

[21] Furthermore, the signal generation unit may be a signal delay unit for generating a
delay signal of the received navigation signal as the interference signal.

[22] Meanwhile, a navigation signal simulation system in a jamming environment
according to the present invention may include the navigation signal simulation
apparatus in a jamming environment mounted on an operating vehicle being operated,
the satellite navigation receiver mounted on the operating vehicle and connected to the
navigation signal simulation apparatus in a wired manner, and the satellite navigation
jammer mounted on the operating vehicle and connected to the navigation signal
simulation apparatus in a wired manner.

[23]
**Advantageous Effects of Invention**

[24] As described above, the apparatus and system for simulating a navigation signal in a jamming environment according to the present invention can simulate a navigation signal in a jamming environment by synthesizing the navigation signal of a navigation satellite received through a real antenna and a jamming signal which is in a step before the radiation of the antenna from a jammer.

[25] Accordingly, a navigation signal in a jamming environment can be simulated using a simple construction even without radiating the signal of a jammer in the air. Furthermore, a navigation signal influenced by a jamming signal can be simulated at various positions using a navigation signal received through a real antenna. Accordingly, a navigation signal in an operating vehicle, such as vehicles and aircraft, can be simulated.

[26] Furthermore, the performance of a satellite navigation jammer and the performance of a satellite navigation receiver can be tested at the same time by mounting the satellite navigation jammer and the satellite navigation receiver on the same operating vehicle and operating them.

[27] Furthermore, the processing performance of the satellite navigation receiver for a delayed navigation signal can be checked by delaying a received navigation signal and providing the delayed navigation signal.

[28] Furthermore, the position of a jammer can be set in various ways by modulating and providing the phase or amplitude of a jamming signal or a delay signal with respect to a satellite navigation receiver including a plurality of antenna input terminals.

[29] **Brief Description of Drawings**

[30] FIG. 1 is a schematic diagram showing a navigation signal simulation apparatus in a jamming environment according to an embodiment of the present invention.

[31] FIG. 2 is a schematic diagram showing a navigation signal simulation apparatus in a jamming environment according to another preferred embodiment of the present invention.

[32] FIG. 3 is a block diagram showing an interference signal generation unit included in the navigation signal simulation apparatus in a jamming environment according to the present invention.

[33] FIG. 4 is a block diagram showing a signal delay unit included in the navigation signal simulation apparatus in a jamming environment according to the present invention.

[34] FIG. 5 is a schematic diagram showing a navigation signal simulation apparatus in a jamming environment according to yet another preferred embodiment of the present invention.
invention

[35] FIG. 6 is a block diagram showing an interference signal generation unit included in
the navigation signal simulation apparatus in a jamming environment according to yet
another preferred embodiment of the present invention and

[36] FIG. 7 is a schematic diagram showing a navigation signal simulation system in a
jamming environment according to the present invention.

[37]

Mode for the Invention

[38] An apparatus and system for simulating a navigation signal in a jamming en-
vironment according to the present invention will be described in detail below with
reference to the accompanying drawings.

[39] It is assumed that the term 'interference signal' described in this specification refers
to both a jamming signal generated by a satellite navigation jammer and a delay signal
generated by the navigation signal simulation apparatus in a jamming environment
according to the present invention.

[40] FIG. 1 is a schematic diagram showing a navigation signal simulation apparatus in a
jamming environment according to an embodiment of the present invention.

[41] As shown in FIG. 1, the navigation signal simulation apparatus in a jamming en-
vironment includes an antenna 110 for receiving a navigation signal from a navigation
satellite, an interference signal generation unit 130 for generating an interference signal
to limit the normal reception of the navigation signal, and a navigation signal synthesis
unit 150 for synthesizing the navigation signal and the interference signal and
outputting a synthesized signal to the antenna input port of a satellite navigation
receiver.

[42] The antenna 110 receives the navigation signal of a navigation satellite. Various
kinds of antennas may be used as the antenna 110. Furthermore, an antenna array
including a plurality of lower antennas may be used as the antenna 110.

[43] Satellite navigation is navigation using an artificial satellite as a reference point for
position measurement. The satellite navigation is navigation for monitoring an electric
wave emitted by a satellite, checking its own position using satellites as relay stations,
or determining a course according to guidance. Here, the satellites used for the satellite
navigation are called navigation satellites. Separate navigation for only the satellite
navigation rarely exists. Accordingly, the navigation satellites in this specification are
assumed to include satellites capable of providing the function of the satellite
navigation.

[44] The navigation satellites may be classified into PS navigation satellites, GLONASS
navigation satellites, and Galileo navigation satellites according to the type of the
satellite navigation. The navigation satellites according to the present invention include all kinds of navigation satellites.

[45] The interference signal generation unit 130 generates an interference signal to limit the normal reception of a navigation signal. A representative interference signal includes a jamming signal generated and radiated by a satellite navigation jammer. Since a navigation signal can be easily jammed, the satellite navigation jammer can jam the navigation signal by only generating and radiating the representative jamming signal. The satellite navigation jammer may jam a navigation signal by receiving the navigation signal, modulating the received navigation signal, and radiating the modulated navigation signal.

[46] A navigation signal is chiefly used to check a current position. Accordingly, a navigation signal, received with delay for a certain time, may correspond to an interference signal. This is because the time-delayed and received navigation signal leads a satellite navigation receiver to check the past position rather than the current position.

[47] For this reason, the interference signal according to the present invention may include both a jamming signal and a delay signal.

[48] The navigation signal synthesis unit 150 synthesizes the navigation signal received through the antenna 110 and the interference signal generated by the interference signal generation unit 130 and transfers a synthesized signal to the satellite navigation receiver. Accordingly, the satellite navigation receiver is in a condition that it has received the navigation signal in a jamming environment.

[49] In the case where the satellite navigation receiver includes a plurality of antenna input terminals, the navigation signal synthesis unit 150 may output the same number of synthesis signals as the number of the antenna input terminals.

[50] Here, in the case where one navigation signal is received through the antenna and one interference signal is outputted by the interference signal generation unit, the satellite navigation receiver may include means for diverging the navigation signal and the interference signal as many as the number of the antenna input terminals and synthesizers as many as the number of the antenna input terminals for synthesizing each of the diverged signals.

[51] If interference signals as many as the number of the antenna input terminals are outputted by the interference signal generation unit 130, the means for diverging the interference signals as many as the number of antenna input terminals may be omitted.

[52] Meanwhile, in the case where the interference signal generation unit 130 is a satellite navigation jammer for generating a jamming signal using a navigation signal received through an antenna or the interference signal generation unit includes means for generating a time-delayed and received navigation signal (that is, a delay signal), the interference signal generation unit 130 has to be able to receive the navigation signal
received through the antenna.

[53] FIG. 2 is a schematic diagram showing a navigation signal simulation apparatus in a jamming environment according to another preferred embodiment of the present invention.

[54] As shown in FIG. 2, the navigation signal simulation apparatus in a jamming environment includes an antenna 110 for receiving a navigation signal from a navigation satellite, an interference signal generation unit 130 for generating an interference signal to limit the normal reception of the navigation signal, a navigation signal synthesis unit 150 for synthesizing the navigation signal and the interference signal and outputting the synthesized signal to the antenna input port of a satellite navigation receiver, and a navigation signal branching unit 170 for branching the received navigation signal into a first navigation signal transferred to the interference signal generation unit 130 and a second navigation signal transferred to the navigation signal synthesis unit 150.

[55] The interference signal generation unit 130 may receive the first navigation signal and use the first navigation signal to generate the interference signal. More particularly, the interference signal generation unit 130 may generate a delay signal and may generate a jamming signal by modulating the first navigation signal.

[56] Furthermore, the navigation signal synthesis unit 150 synthesizes the second navigation signal and the interference signal and outputs a synthesized signal to the satellite navigation receiver.

[57] The navigation signal branching unit 170 branches the navigation signal, received through the antenna 110, into a navigation signal transferred to the interference signal generation unit 130 and a navigation signal transferred to the navigation signal synthesis unit 150. For convenience sake, the former navigation signal is called the first navigation signal, and the latter navigation signal is called the second navigation signal. From a viewpoint of the navigation signal branching unit 170, there are three navigation signals, including the navigation signal received through the antenna 110, the first navigation signal, and the second navigation signal, but the three navigation signals have the same signal characteristic.

[58] When the antenna 110 comprises an antenna array, the navigation signal branching unit 170 may branch all navigation signals of a plurality of respective lower antennas.

[59] Alternatively, when the antenna 110 comprises a plurality of lower antennas, the navigation signal branching unit 170 may branch one of the lower antennas.

[60] One of the objects to construct the antenna using a plurality of lower antennas is to determine the angle of arrival of a signal received through each of the lower antennas by analyzing the amplitude or phase of the received signal.

[61] Accordingly, in the case where the satellite navigation receiver needs not to determine the angle of arrival of a received signal or the interference signal generation
unit simulates the angle of arrival of a received signal, even though the antenna includes a plurality of lower antennas, the navigation signal branching unit 170 can branch the navigation signal of one of the lower antennas. This can make the system simplified.

[62] The interference signal generation unit of the navigation signal simulation apparatus in a jamming environment shown in FIGS. 1 and 2 is described in detail below.

[63] FIG. 3 is a block diagram showing the interference signal generation unit included in the navigation signal simulation apparatus in a jamming environment according to the present invention.

[64] The interference signal generation unit 130 of FIG. 3 may include a jamming signal reception unit 131 for receiving a jamming signal from a satellite navigation jammer as an interference signal, where the jamming signal is a signal before the radiation by the antenna.

[65] The satellite navigation jammer may generate the jamming signal by modulating a first navigation signal according to characteristics. Here, the jamming signal reception unit 131 can send the first navigation signal to the satellite navigation jammer.

[66] Furthermore, the satellite navigation jammer may generate the jamming signal of a navigation signal even without receiving the navigation signal which is an object of jamming according to characteristics. The jamming signal reception unit 131 needs not to send the first navigation signal to the satellite navigation jammer.

[67] Accordingly, the jamming signal reception unit may receive or not receive the first navigation signal from the navigation signal branching unit according to characteristic of the satellite navigation jammer. In FIG. 3, a dotted arrow is indicated in order to represent this condition.

[68] In other words, when the interference signal generation unit includes only the jamming signal reception unit as an element for generating the interference signal, the interference signal generation unit may receive or not receive the first navigation signal according to circumstances.

[69] Meanwhile, the interference signal generation unit 130 may include a signal delay unit 120 for generating the delay signal of a first navigation signal as an interference signal. Since the first navigation signal is necessary to generate the delay signal, the interference signal generation unit 130 must receive the first navigation signal if the signal delay unit 120 is included.

[70] The navigation satellite for generating and radiating the navigation signal is plural. Accordingly, the navigation signal received through the antenna includes a plurality of navigation signals from the plurality of navigation satellites. Thus, the first navigation signal having the same characteristic as the navigation signal received through the antenna also includes a plurality of navigation signals from a plurality of navigation
satellites.

[71] Here, the signal delay unit 120 may delay the navigation signal of a navigation satellite selected by a user.

[72] FIG. 4 is a block diagram showing the signal delay unit included in the navigation signal simulation apparatus in a jamming environment according to the present invention.

[73] In the case where a first navigation signal includes navigation signals of a plurality of navigation satellites, the signal delay unit 120 may include a satellite selection unit 121 for separating the first navigation signal into the navigation signals of the respective navigation satellites and selecting the navigation signal of a target navigation satellite, a time delay unit 123 for delaying the time of the selected navigation signal, and a delay synthesis unit 125 for synthesizing the time-delayed navigation signal and unselected navigation signals of the separated navigation signals and outputting a synthesized signal.

[74] The satellite selection unit 121 separates channels of the respective navigation satellites by analyzing the first navigation signal, and it may be configured using an RF structure or a digital structure. The navigation signal of a channel selected by a user (that is, a target navigation satellite), from among the separated channels, may be plural. Furthermore, the navigation signal of the target navigation satellite may be all the navigation signals of the respective separated navigation satellites.

[75] Furthermore, if the navigation signal is not selected by a user, the satellite selection unit 121 may select the navigation signal of a target navigation satellite set as a basic value.

[76] The time delay unit 123 delays the time of the selected navigation signal. Here, the delayed time may be set within several ms which affect the reception of a navigation signal. Furthermore, the time delay unit 123 may delay the navigation signals with different delay times. To this end, the time delay unit 123 may include lower time delay units 124 corresponding to the respective navigation satellites. A delay time optimized in terms of hindrance may be applied to each navigation satellite.

[77] Furthermore, the time delay unit 123 includes the lower time delay units 124 with different delay times and may variously change a delay time applied to the same navigation satellite according to user selection.

[78] In the case where the plurality of lower time delay units 124 is included, the time delay unit 123 may include a switch for selecting the lower time delay unit to which the output signal of the satellite selection unit 121 is inputted.

[79] The delay synthesis unit 125 synthesizes unselected navigation signals (that is, not-delayed navigation signals), from among the navigation signals separated by the satellite selection unit 121, and the navigation signal time-delayed by the time delay
unit 123. The delay signal that is the output signal of the delay synthesis unit 125
becomes the first navigation signal delayed from the navigation signal selected by a
user. When a user selects all navigation satellites, the delay signal becomes the first
navigation signals of which all are delayed.

Any one of or both the signal delay unit 120 and the jamming signal reception unit
131 may be formed in the interference signal generation unit 130.

That is, the interference signal generation unit 130 may include both the jamming
signal reception unit 131 for receiving a jamming signal (in a step before the radiation
of the antenna) from the satellite navigation jammer as an interference signal and the
signal delay unit 120 for generating the delay signal of the first navigation signal as the
interference signal. The interference signal generation unit 130 may include an
interference signal selection unit 133 for selecting at least one of the delay signal and the
jamming signal and outputting a selected signal to the navigation signal synthesis unit
150.

FIG. 5 is a schematic diagram showing a navigation signal simulation apparatus in a
jamming environment according to yet another preferred embodiment of the present
invention.

As shown in FIG. 5, the navigation signal simulation apparatus in a jamming
environment includes an antenna 110, an interference signal generation unit 230, a
navigation signal synthesis unit 150, and a navigation signal branching unit 170.

A satellite navigation receiver includes a plurality of antenna input ports. The
antenna 110 includes the same number of lower antennas 111 as the number of antenna
input ports of the satellite navigation receiver.

Furthermore, the interference signal generation unit 230 generates the same number
of interference signals as the number of antenna input ports of the satellite navigation
receiver. FIG. 5 shows the satellite navigation receiver having, for example, five
antenna input ports.

Furthermore, the signal synthesis unit 150 synthesizes the interference signals,
generated by the interference signal generation unit 230, and the respective navigation
signals of the lower antennas 111 and outputs the synthesized signals to the respective
antenna input ports of the satellite navigation receiver.

In the constructions of FIGS. 1 and 2, the antenna 110 may be configured to have the
antenna array structure including the plurality of lower antennas 111 as shown in FIG.
5. Here, the number of lower antennas 111 may not depend on the number of antenna
input ports of the satellite navigation receiver.

However, in FIG. 5, the number of lower antennas 111 is the same as the number of
antenna input ports of the satellite navigation receiver.

This is for the purpose of verifying a construction including even a reception antenna
when the performance of the satellite navigation receiver is verified. Accordingly, in the present embodiment, the antenna 110 may be the antenna of the satellite navigation receiver.

According to the present embodiment, the interference signal generation unit 230 also generates the same number of interference signals as the number of antenna input ports of the satellite navigation receiver.

In the satellite navigation receiver equipped with the plurality of lower antennas, although the same interference signals are received, there is a difference in the interference signals received through the respective lower antennas. In order to simulate the interference signals, the interference signal generation unit 230 also generates the same number of interference signals as the number of antenna input ports of the satellite navigation receiver.

FIG. 6 is a block diagram showing the interference signal generation unit 230 included in the navigation signal simulation apparatus in a jamming environment according to yet another preferred embodiment of the present invention.

The interference signal generation unit 230 of FIG. 6 includes a signal generation unit 231 for generating interference signals, a channel distributor 235 for distributing the generated interference signals into the channels of the respective antenna input ports, and an angle-of-arrival simulation unit 237 for modulating and outputting at least one of the amplitude and phase of each of the distributed interference signals.

The signal generation unit 231 is an element for generating the interference signal. To this end, the signal generation unit 231 may be a jamming signal reception unit 233 for receiving a jamming signal (in a step before the radiation of the antenna) from a satellite navigation jammer as the interference signal.

Alternatively, the signal generation unit 231 may be a signal delay unit 232 for generating the delay signal of a navigation signal received as the interference signal.

Alternatively, the signal generation unit may include both the signal delay unit 232 and the jamming signal reception unit 233 and may further include an interference signal selection unit 234 for selecting at least one of the signal delay unit 232 and the jamming signal reception unit 233.

The channel distributor 235 distributes the interference signals, generated by the signal generation unit 231, into the channels of respective antenna input ports of the satellite navigation receiver. Here, all the distributed interference signals according to the respective channels have the same characteristic. Accordingly, if the interference signals are outputted to the navigation signal synthesis unit, all the interference signals are considered as being entered from the front from a viewpoint of the satellite navigation receiver.

Accordingly, the angle-of-arrival simulation unit 237 is used to verify the angle of
arrival at which the interference signal is received.

[100] In order to estimate the angle of arrival of a specific signal, a plurality of antennas is used and a phase difference or an amplitude difference between the signals received through the respective antennas is employed. The angle-of-arrival simulation unit 237 modulates the phase or amplitude of each of the output signals of the channel distributor 235 by reversely employing the method of estimating the angle of arrival. In order to differently modulate the phase or amplitude of each output signal, the channel distributor 235 may include a plurality of phase/amplitude modulation units 238.

[101] FIG. 7 is a schematic diagram showing a navigation signal simulation system in a jamming environment according to the present invention.

[102] The navigation signal simulation system shown in FIG. 7 includes the navigation signal simulation apparatus 100 in a jamming environment described with reference to FIGS. 1 to 6, a satellite navigation receiver 300 connected to the navigation signal simulation apparatus 100 in a wired manner, and a satellite navigation jammer 400 connected to the navigation signal simulation apparatus 100 in a wired manner. All the navigation signal simulation apparatus 100, the satellite navigation receiver 300, and the satellite navigation jammer 400 are mounted on the same operating vehicle which is running.

[103] The navigation signal simulation apparatus 100 has to include at least the jamming signal reception units 131 and 233 for connection to the satellite navigation jammer 400. Whether to include the signal delay unit may be determined by a user. Furthermore, the signal delay unit may be further included, and the interference signal selection unit may be configured to select at least one of the delay signal of the signal delay unit and the jamming signal of the satellite navigation jammer.

[104] The operating vehicle includes vehicles and seacraft (that is, a low maneuver vehicle) and aircraft (that is, a high maneuver vehicle).

[105] Here, the navigation signal simulation system in a jamming environment may have a programmable GPS electric wave interference signal generation operation control function embedded therein so that it can be operated in an unmanned environment. To this end, the navigation signal simulation system may include a storage unit for storing a program module of the operation control function and a control unit for performing the operation control function by processing the module. The storage unit and the control unit may be included in the navigation signal simulation apparatus 100.

[106] Accordingly, a user can operate the frequency, type, intensity, etc. of electric wave interference according to a scheduled operation/navigation environment by using a previously written electric wave interference profile without additional complicated manipulation, such as a wired or wireless manner.

[107] According to the above construction, the performance of a satellite navigation
receiver, including the reception state of a navigation signal varying according to geographical features of each position, can be verified.

[108] Furthermore, there is no legal problem because the output signal of a satellite navigation jammer is processed in a wired manner and then inputted to only the navigation signal simulation apparatus. In addition, a navigation signal in a jamming environment used to verify the performance of a satellite navigation receiver or a satellite navigation jammer can be simulated.

[109] While the invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

[110] **Industrial Applicability**

[111] The present invention may be applied to a navigation signal simulation apparatus in a jamming environment.

[112] In particular, the present invention is advantageous in a situation in which a jamming signal cannot be radiated in the air.

[113] Furthermore, the present invention may be applied to a system for verifying the performance of a satellite navigation receiver mounted on an operating vehicle being dynamically operated. Moreover, the present invention may be applied to a system for verifying a satellite navigation jammer for jamming a satellite navigation receiver mounted on an operating vehicle being dynamically operated.
Claims

[Claim 1] A navigation signal simulation apparatus in a jamming environment, comprising:
an antenna for receiving a navigation signal of a navigation satellite,
an interference signal generation unit for generating an interference
signal to limit a normal reception of the navigation signal, and
a navigation signal synthesis unit for synthesizing the navigation signal
and the interference signal and outputting the synthesized signal to an
antenna input port of a satellite navigation receiver.

[Claim 2] The navigation signal simulation apparatus of claim 1, further
comprising a navigation signal branching unit for branching the
received navigation signal into a first navigation signal transferred to
the interference signal generation unit and a second navigation signal
transferred to the navigation signal synthesis unit,
wherein the interference signal generation unit receives the first
navigation signal and uses the first navigation signal to generate the
interference signal, and
the navigation signal synthesis unit synthesizes the second navigation
signal and the interference signal.

[Claim 3] The navigation signal simulation apparatus of claim 2, wherein:
the antenna comprises a plurality of lower antennas, and
the navigation signal branching unit branches navigation signals of one
of the respective lower antennas.

[Claim 4] The navigation signal simulation apparatus of any one of claims 1 to 3,
wherein the interference signal generation unit comprises a jamming
signal reception unit for receiving a jamming signal which is in a step
before a radiation of the antenna from a satellite navigation jammer as
the interference signal.

[Claim 5] The navigation signal simulation apparatus of claim 2 or 3, wherein the
interference signal generation unit comprises a signal delay unit for
generating a delay signal of the first navigation signal as the
interference signal.

[Claim 6] The navigation signal simulation apparatus of claim 5, wherein:
the first navigation signal comprises the navigation signals of a
plurality of the navigation satellites, and
the signal delay unit comprises:
a satellite selection unit for separating the first navigation signal into
the navigation signals of the respective navigation satellites and selecting the navigation signal of a target navigation satellite, a time delay unit for delaying a time of the selected navigation signal, and a delay synthesis unit for synthesizing the time-delayed navigation signal and unselected navigation signals of the separated navigation signals and outputting the synthesized navigation signal.

[Claim 7] The navigation signal simulation apparatus of claim 6, wherein the time delay unit comprises a lower time delay unit corresponding to each of the navigation satellites.

[Claim 8] The navigation signal simulation apparatus of claim 2 or 3, wherein the interference signal generation unit comprises: a jamming signal reception unit for receiving a jamming signal which is in a step before a radiation of the antenna from a satellite navigation jammer as the interference signal, a signal delay unit for generating a delay signal of the first navigation signal as the interference signal, and an interference signal selection unit for selecting at least one of the delay signal and the jamming signal and outputting the selected signal to the signal synthesis unit.

[Claim 9] The navigation signal simulation apparatus of any one of claims 1 to 3, wherein: the satellite navigation receiver comprises a plurality of antenna input ports, the antenna comprises lower antennas having an identical number with a number of antenna input ports, the interference signal generation unit generates the interference signal having an identical number with the number of antenna input ports, and the signal synthesis unit synthesizes the interference signals and the navigation signals of the respective lower antennas.

[Claim 10] The navigation signal simulation apparatus of claim 9, wherein the antenna is an antenna of the satellite navigation receiver.

[Claim 11] The navigation signal simulation apparatus of claim 9, wherein the interference signal generation unit comprises: a signal generation unit for generating the interference signals, a channel distributor for distributing the generated interference signals into channels of the respective antenna input ports, and an angle-of-arrival simulation unit for modulating at least one of an
amplitude and phase of each of the distributed interference signals and outputting the modulated signal.

[Claim 12] The navigation signal simulation apparatus of claim 10, wherein the signal generation unit is a jamming signal reception unit for receiving a jamming signal which is in a step before a radiation of the antenna from the satellite navigation jammer as the interference signal.

[Claim 13] The navigation signal simulation apparatus of claim 10, wherein the signal generation unit is a signal delay unit for generating a delay signal of the received navigation signal as the interference signal.

[Claim 14] A navigation signal simulation system in a jamming environment, comprising:
- a navigation signal simulation apparatus in a jamming environment according to claim 4 which is mounted on an operating vehicle being operated;
- a satellite navigation receiver mounted on the operating vehicle and connected to the navigation signal simulation apparatus in a wired manner and
- a satellite navigation jammer mounted on the operating vehicle and connected to the navigation signal simulation apparatus in a wired manner.

[Claim 15] A navigation signal simulation system in a jamming environment, comprising:
- a navigation signal simulation apparatus in a jamming environment according to claim 8 which is mounted on an operating vehicle being operated;
- a satellite navigation receiver mounted on the operating vehicle and connected to the navigation signal simulation apparatus in a wired manner; and
- a satellite navigation jammer mounted on the operating vehicle and connected to the navigation signal simulation apparatus in a wired manner.
[Fig. 5]

Interference Signal Generation unit

Coupler

Synthesizer

Navigation Signal Branching unit

Navigation Signal Synthesis unit

Satellite Navigation Receiver