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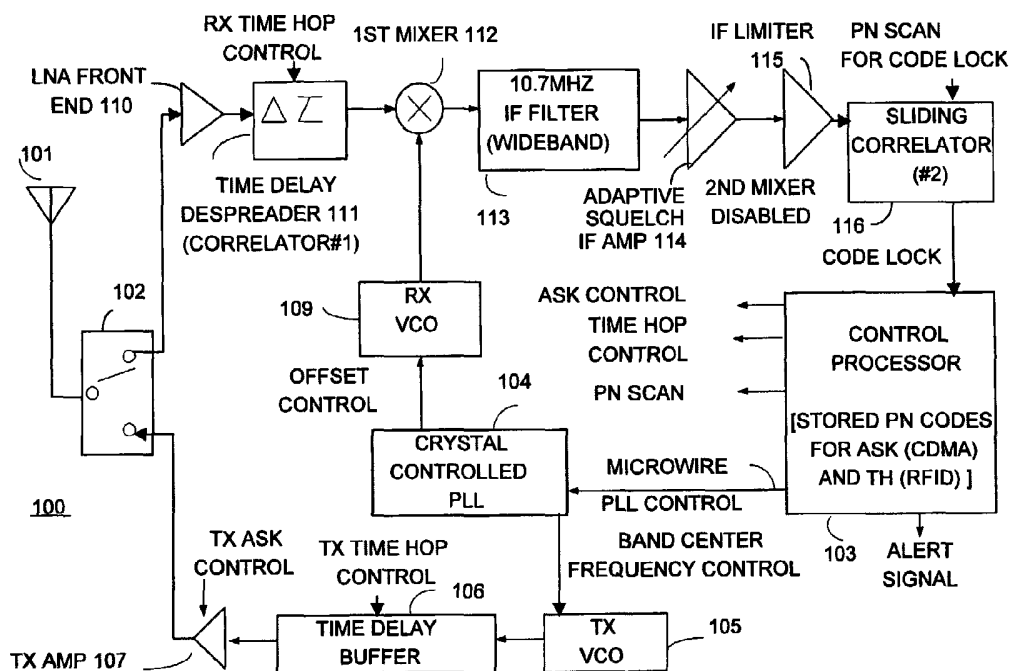
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(54) Title: METHOD AND APPARATUS FOR AVOIDING COLLISIONS



(57) Abstract: An apparatus and method is provided for avoiding collisions by detecting multiple targets and making an alert. The apparatus has transmit and receive functions. The transmitter transmits signals that are processed by PDMA protocol. The receiver detects a plurality of targets based on the PDMA protocol to determine a hazardous situation. Multi trails, such as operators of vehicles with the apparatus can be aware that there is another trail or a quick vehicle by alert and avoid collisions in a severe environment.



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Method And Apparatus For Avoiding Collisions

FIELD OF THE INVENTION

This invention relates to an anti-collision method and apparatus and more specifically, to a method and an apparatus for detecting one or more targets for avoiding collisions.

BACKGROUND OF THE INVENTION

With the increasing popularity of new type personal vehicles, such as snowmobiles, all terrain vehicles (ATVs) and watercraft, it has been important to establish technology for collision avoidance.

For example, in a dense bush covered with snow, a snowmobile operator may not avoid collision with another snowmobile that approaches at high speed. That may result in a serious accident.

Similarly, in a severe environment, it is difficult for the operators of any kind of vehicles as well as pedestrians, dog sleds, horse sleighs or cross country skiers to be aware of impending danger due to collision.

It is, therefore, desirable to provide a method and apparatus for avoiding collisions or proximity to offer safety across all trails.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus and method for detecting one or more targets to avoid collisions.

The invention uses a Pulse Division Multiple Access (PDMA) protocol.

In accordance with an aspect to the present invention, there is provided a method for avoiding collisions. The method comprises the steps of transmitting and receiving a signal processed by the PDMA protocol, and detecting one or more targets based on the received signals to provide an alert to vehicle operators to enable them to take action to avoid collision with another vehicle.

In accordance with another aspect to the present invention, there is provided an apparatus for avoiding collisions. The apparatus comprises a transmitter for transmitting a signal processed by a Pulse Division Multiple Access (PDMA) protocol, a receiver for receiving one or more target signals processed by the PDMA protocol and extracting a target signal, and a control processor to alert an operator that another vehicle is in range and avoidance action should be taken.

Other aspects and features of the present invention will be readily apparent to those skilled in the art from a review of the following detailed description of preferred embodiments in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further understood from the following description with reference to the drawings in which:

Figure 1 is a block diagram of the core components of the trail alert equipment and their interconnections in accordance with an embodiment of the present invention;

Figure 2 is a pictorial diagram illustrating a scenario showing interaction of vehicles in accordance with an embodiment of the present invention;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The trail alert equipment in accordance with an embodiment of the present invention detects multiple transmitters (targets) and isolates them from each other. Also, the trail alert equipment in accordance with an embodiment of the present invention makes a visual and/or audio alert based on range and speed estimation for avoiding collisions.

The trail alert equipment in accordance with an embodiment of the present invention uses a Pulse Division Multiple Access (PDMA) protocol. The concept of the PDMA protocol used in the invention comprises the Amplitude

Shift Keying (ASK) technique of Direct Sequence Spread Spectrum (DSSS) and the Radio Frequency Time Hopping technique of Ultra Wideband (UWB). The Time hopping code serves as Radio Frequency Identification (RFID). The details of the PDMA protocol will be described below.

Fig. 1 shows the core components and their interconnections of the trail alert equipment in accordance with an embodiment of the present invention. The trail alert transceiver 100 has a receiver and a transmitter (receive and transmit functions). These functions work in an omnidirectional manner. The trail alert transceiver 100 comprises an antenna 101, a transmit/receive switch 102, a control processor 103, a crystal oscillator controlled phase locked loop (PLL) 104, a transmit voltage controlled oscillator (TX VCO) 105, a time delay buffer 106 and a transmit amplifier (TX amp) 107.

The antenna 101 is an element to send and receive radio signals. The transmit/receive switch 102 connects the antenna 101 either to the transmit or to the receive circuitry. The control processor 103 is a central processing unit (CPU) which generates the various Pseudo-random Noise (PN) codes used both for RFID (time hop codes) and Code Division Multiple Access (CDMA) (ASK codes). The control processor 103 outputs an ASK control signal, a time hop control signal, a PN scan signal and a PLL control signal.

The crystal oscillator controlled PLL 104 is an element which comprises a highly accurate quartz crystal to generate multiple timing frequencies. The crystal oscillator controlled PLL 104 receives the PLL control signal from the control processor 103 and outputs an offset control signal and a band center frequency control signal.

The TX VCO 105 is an element that generates the timing frequency (carrier) for radio transmission based on the band center frequency control signal output from the crystal controlled PLL 104. The output of the TX VCO 105 is supplied to the time delay buffer 106.

The time delay buffer 106 is an element which time-hops the carrier in response to the time hop control signal output from the control processor 103. The output of the time delay buffer 106 is supplied to the TX amplifier 107.

The TX amplifier 107 is an element which generates the transmit chips by switching the time-hopped carrier on and off in response to the ASK control signal output from the control processor 103. The output of the TX amplifier 107 is supplied to the switch 102.

The trail alert transceiver 100 further comprises a receive voltage controlled oscillator (RX VCO) 109, a low noise amplifier (LNA) 110, a time delay despreaders 111, a first mixer 112, a 10.7 MHz intermediate frequency (IF) filter 113, an adaptive squelch IF amplifier (IF amp) 114, an IF limiter 115 and a sliding correlator 116.

The RX VCO 109 receives the offset control signal output from the crystal controlled PLL 104 and generates the timing frequency used by the first mixer 112. The LNA 110 is an element which amplifies the weak signal received by the antenna 101. The output of the LNA 110 is supplied to the time delay despreaders 111.

The time delay despreaders 111 is an element which reverses the time hopping of the received carrier chips. The outputs from the time delay despreaders 111 and the RX VCO 109 are supplied to the first mixer 112. The first mixer 112 is an element which converts the high frequency of the received signal to a lower intermediate frequency (IF). The output of the first mixer 112 is supplied to the 10.7 MHz IF filter 113.

The 10.7 MHz IF filter 113 is an element which acts on the received IF frequency to remove all unwanted noise and interfering signals. The output of the 10.7 MHz IF filter 113 is supplied to the adaptive squelch IF amplifier 114. The adaptive squelch IF amplifier 114 is an element which separates out the 16 range codes (ASK levels) by slicing the amplitudes. The output of the adaptive squelch IF amplifier 114 is supplied to the IF limiter 115.

The IF limiter 115 is an element which converts the IF signal into a logic level data signal. The output of the IF limiter 115 is supplied to the sliding correlator 116. The sliding correlator 116 is an element which locks onto each of the 16 range codes and determines which of the distance codes are present in response to the PN scan signal output from the control processor 103. The control processor 103 produces an alert signal based on the output of the sliding correlator 116.

The trail alert transceiver 100 acts as an active tag, which transmits an identification (ID) code to the other vehicles having the trail alert transceivers. Also, the trail alert transceiver 100 indirectly acts as an interrogator, which receives the ID codes transmitted by the other trail alert transceivers.

The transmitter of the trail alert transceiver 100 sends 16 simultaneous PN code sequences. The ASK is used to create 16 separate "range codes" (carrier amplitudes). The coding can be either PN or one of the other CDMA codes. There are 1000 chips per code and 16 codes, for a total of 16,000 chips. It is noted that the "chip" refers to a slice of the range code. The chips are time-shifted (hopped). Time hopping uses yet another PN code, of 16 separate time shifts, for a total of 256,000 chips in a two-dimensional array (time shift and amplitude shift) as a "constellation".

The receiver of the trail alert transceiver 100 despreads the received PN codes and extracts a unique subset of PN sequence based on the amplitude level. The control processor 103 estimates range and speed of the extracted PN sequences by analyzing the range code (distance) for each ID code (other radio) and outputs alert signals. The indicator/alarm (not shown) produces a sound/light alert based on the alert signals output from the control processor 103.

Range estimation produces a variable sound/light effect. The sound/light effect indicates relative distance. For example, when the control processor 103 determines that the target is closer, beeping is faster. The operator on the vehicle can turn off the alert sound/light. Approaching speed is

estimated by tracking the change in distance, and a rapidly approaching vehicle within a certain range will always cause a panic alarm, even if the distance monitor is turned off. Another indicator, such as vibration, may be used.

Fig.2 shows an example of a scenario in accordance with an embodiment of the present invention. Referring to Fig.2, there are 3 vehicles 200-202. Each vehicle 200-202 has the trail alert equipment 210-212 in accordance with an embodiment of the present invention. All of the trail alert equipments include the trail alert transceiver 100. Each of the vehicles senses the other two vehicles. More specifically, each vehicle receives the other vehicle's RF transmissions, separates out their unique ID codes using time hop despreading and estimates their range and speed using amplitude shift despreading (adaptive squelch sliding correlator). If the vehicle 201 is rapidly approaching the vehicle 200 within a certain range, the trail alert equipment of the vehicle 200 causes a panic alarm. For example, the vehicle may be a snowmobile which can move at a speed of 200km per hour. The trail alert equipment can achieve more than 500 ft range in line of sight.

The trail alert equipment can be applied to any kind of vehicle, such as an airplane, a boat, a ship, a train, a snowmobile and an ATV.

In Figure 2, the trail alert equipment is mounted on the vehicle. However, it does not need to be on a vehicle and it may be used in any kind of situation in which there is possible collision or proximity. For example, by attaching the trail alert equipment to animals, pedestrians, dog sleds, horse sleighs or cross country skiers, collision avoidance can be achieved.

The trail alert equipment can also be used as fence, establishing a line, an area or perimeter. The vehicles, animals or people equipped with the trail alert invention will obtain warnings from the fence when they approach within a certain distance of it.

The trail alert equipment can position targets based on its processing of the outputs of a vehicle location system, such as a GPS (Global Positioning System) receiver. The GPS receiver receives GPS signals and determines its

position. In this case, the trail alert equipment may display the hostile target position based on the range estimation and its position determined by the GPS receiver.

The trail alert equipment mounted on an aircraft can provide safe routes, especially, with navigation systems, such as AFCF (Auto Flight Control System) or Automatic Pilot System (APS).

The trail alert equipment can transmit the alert signal to the other vehicles. The trail alert equipment can receive the alert signal output from the other vehicles and can produce a visual and/or audio signal. In the scenario shown in Figure 2, the trail alert equipment 201 receives the alert signal and make a visual and/or audio signal that indicates that vehicle 200 identifies the vehicle 201 as "hostile target".

The receiver and the transmitter of the trail alert equipment can be deployed separately.

DIRECT SEQUENCE SPREAD SPECTRUM (DSSS)

Frequency Hopping Spread Spectrum (FHSS) radios are widely used. They implement a pseudo-random sequence of frequency changes, or "hops", which give them advantages over normal narrowband radio links. Because of practical limitations, the hop rate is too slow to be useful for range or speed estimation.

DSSS radios have more capabilities than FHSS. The radio carrier is modulated by a pseudo-random sequence of "chips", being very short time interval bursts, that change the frequency, phase or amplitude of the carrier. The time interval of a chip is much shorter than a single data bit, and so the information is randomized in a very secure way. The ability to separate out one radio transceiver from a large number of interfering units is called CDMA (Code Division Multiple Access), and is directly related to the short chip time compared to the longer bit time, known as Coding Gain. Also, the short chip

time allows range and speed detection to be done between two transceivers, although in a rather complex way, based on a co-operative exchange of data.

In the conventional CDMA system, each transceiver must first send a pseudo-random sequence (PN code), then switch to receive and wait for an answering PN code from the other end. By correlating (synchronizing) the sent and received phase differences in the PN code, the transit time can be estimated, given the known speed of radio waves. Only one pair of transceivers at a time can take part in this co-operative exchange of data. However, in the Trail Alert environment, multiple targets will be moving in and out of range, and all will be transmitting independently. Given the approach speeds of various all terrain vehicles (ATVs), there is simply no time for multiple receivers to arbitrate and synchronize their data streams. The CDMA aspect of DSSS is actually a hindrance to multiple target ranging.

The Trail Alert PDMA concept in accordance with an embodiment of the present invention uses aspects of DSSS as part of its operation along with time-hopping technique as mentioned below.

ULTRA WIDEBAND (UWB)

UWB devices employ "time hopping" (TH) of very short shaped radio pulses using pseudo-random PN codes, just as DSSS uses PN modulation of a radio carrier. The extremely wideband nature of these pulses and the very fast TH rate makes for a very secure link and a very accurate range/speed detection system. CDMA is an inherent part of UWB, and conventional CDMA technique is also a hindrance to the Trail Alert multiple target ranging and speed estimation requirement, just as is the case for DSSS, because of the need for co-operative data exchange.

The Trail Alert PDMA protocol in accordance with an embodiment of the present invention also uses aspects of the TH aspect of UWB, specifically at lower bandwidths, along with DSSS.

RADIO FREQUENCY IDENTIFICATION (RFID)

RFID refers to a general principle in which a network of wireless (RF in the present invention) transceivers arrange their transmissions in such a way as to avoid conflict. For example, RFID radios are used for package location, toll road vehicle tags, etc. An interrogator (the master radio) blindly sends a request for information, and multiple tags (slave radios) may answer simultaneously. Various protocols, such as master/slave protocols used in passive RFID tags, are used to avoid collisions between multiple tag transmissions. This technology is well established, but has no range or speed estimation ability.

The trail alert equipment in accordance with an embodiment of the present invention uses RFID protocol as part of the PDMA concept, along with DSSS and UWB formats.

The trail alert transceiver (100) in accordance with an embodiment of the present invention uses CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance), in which all transceivers check for time hop patterns sent by other units that would conflict with their own. If such a conflict is detected, then one or both of the conflicted parties switches to a new time hop pattern of the 16 that are available for each range. If there are no free patterns (meaning that there are more than 16 transceivers all within a given range grouping), then an unavoidable conflict exists and that particular range is blocked. It will clear of its own accord once various vehicles move to another range. The remaining vehicles will then dynamically change their ID codes as needed to eliminate conflict. Each Trail Alert radio in accordance with the present invention tracks the various ID codes to determine who is moving closer or further away. ID code changes are also tracked, just as cell phone IDs are tracked during a handoff from one cell to another.

PULSE DIVISION MULTIPLE ACCESS (PDMA)

The Trail Alert radios in accordance with the present invention do range and speed estimation without resorting to a co-operative exchange of data, by using a CDMA form of carrier amplitude measurement. Carrier amplitude measurement is also used for range estimation in simple RSSI (Received Signal Strength Indication) systems, but these have many problems related to signal fading, multi-path reflections and path tunneling. The PDMA concept in accordance with the present invention will solve all or most of these problems.

The PDMA concept uses DSSS Amplitude Shift Keying (ASK) modulation to form short chips with a defined number of discrete amplitudes of RF carrier. These chips are time-shifted (hopped), to form a "constellation" of time/amplitude combinations. Each amplitude level of the ASK modulation is individually coded with a specific PN sequence. The amplitude sequence is also PN coded, as the time shifting is done. The amplitude level and amplitude sequence codes are identical for all Trail Alert radios, so that CDMA can be used to isolate their unique signal patterns from other radio sources (non Trail Alert radios).

Assuming a typical situation with 1000 chips per amplitude, 16 discrete amplitudes and 16 discrete time shifts, the result will be a signal with 256,000 unique combinations, a large number which leads to high coding gain, but with individual "chip sets" of only 1000 combinations, meaning that individual range "rough estimates" can be done very quickly, and that missing sequences can be ignored or reconstructed by digital signal processing.

The high coding gain means that short-term signal dropouts and peaks, as well as multiple path reflections, can be detected and the errors mitigated by the receiver's correlator. The results are much superior to simple RSSI. High quality signals can be processed quickly at the "chip set" level, while weak and error-filled signals require more time to do a more complete code acquisition. Since short-range signals (close proximity of one or more targets) are inherently the highest quality, they will be detected quickly, which is important

in the Trail Alert application, where short range targets need to be closely monitored.

The receiver of the trail alert transceiver (100) in accordance with the present invention uses a digitally controlled squelch (adaptive threshold) (114) to separate out the various amplitude levels. At short ranges, all or most of the sequences will be present. As range increases, the codes for the lower amplitudes will disappear or become unreliable. The result is that for any given distance between receiver and transmitter, a unique subset of PN sequences can be extracted from the encoded RF signal. A direct correlation between PN sequence and range can then be established, without the need for multiple targets to co-operatively exchange the same PN sequence.

Each transmitter of the trail alert transceiver (100) in accordance with an embodiment of the present invention can independently transmit a constellation of PN codes, and each receiver can independently receive and despread these codes to estimate the range. The transmission of very short-duration chips means that the population of chips in any given time sequence is very sparse, so that most of the time each transceiver is in receive mode. This allows the same frequency band to be used for both the brief transmit pulse interval and the much longer receive interval. The transmit and receive functions are time interleaved chip by chip, so that effectively the transceiver operates in both modes simultaneously.

Time hopping (TH) of the chips is used to independently encode each target's identification. This ID code is not fixed, but rather changes dynamically as soon as a target conflict is encountered as mentioned above, so that targets with the same initial ID code will time shift away from the conflicting condition in a random way. Uniquely assigned ID codes are not needed in the Trail Alert application, as long as each target within a given detection range (called an "approach band") has a different ID from all of the others. Based on the presence of 16 unique time shift codes per amplitude level, up to 16 targets within the same approach band can be separated from each other, and up to

256 targets total can be accommodated throughout the total detection range (all 16 approach bands). If any given range is overloaded with targets, the range/speed detection is compromised for that specific band only, and other target ranges are largely unaffected. If very large numbers of targets move back and forth within the overall detection range, overload conditions (blocks) will dynamically appear and clear within each band. Under normal conditions, where ATVs maintain reasonable spacing, only the farthest approach bands (500 ft. or more) will possibly be blocked by TH overload.

It is assumed that there are one "hostile" target which is approaching and getting too close and "friendly" targets which are either keeping a reasonable distance, being nearby but not moving closer, or moving away. In the worst case scenario of a "hostile" target approaching at high speed through a cluster of closer "friendly" targets, the probability of all approach bands being overloaded is vanishingly small, and the appearance of the target in one of the closer clear bands surrounded by one or more blocked bands will be cause for alarm. This very unlikely scenario will result in an occasional false alarm which is considered acceptable under the circumstances.

Numerous modifications, variations and adaptations may be made to the particular embodiments of the invention described in the documents attached herein, without departing from the scope of the invention, which is defined in the claims.

What is claimed is:

1. A method of avoiding collisions comprising the steps of:
transmitting and receiving a signal processed by a Pulse Division Multiple Access (PDMA) protocol; and
detecting one or more targets based on the received signals to provide an alert for collision avoidance.
2. The method of claim 1 wherein the step of transmitting and receiving comprises a step of transmitting a code sequence, the transmitting step includes a step of creating a range code and a step of time-hopping a chip which is a slice of the range code.
3. The method of claim 2 wherein the creating step includes a step of performing Amplitude Shift Keying (ASK) modulation to form short chips with a plurality of discrete amplitude of RF carrier.
4. The method of claim 3 wherein the amplitude level of the ASK modulation is coded.
5. The method of claim 2 wherein the step of transmitting and receiving a signal comprises a step of receiving code sequences, the receiving step includes a step of reversing the time hopping of the received chips and a step of extracting a unique range code for determining which of the range codes are present.
6. The method of claim 5 wherein the creating step includes a step of creating carrier amplitudes and the extracting step includes a step of separating out amplitude levels.

7. The method of claim 3 wherein the step of transmitting and receiving comprises a step of receiving code sequences, the receiving step includes a step of reversing the time hopping of the received chips, a step of separating out amplitude levels to extract a unique subset of code sequences, and a step of estimating range and speed of the extracted code.

8. The method of claim 1 wherein the detecting step comprises a step of positioning one or more targets based on the received signals which includes a signal output from a Global Positioning Satellite (GPS) receiver.

9. The method of claim 1 wherein the step of extracting a code includes a step of separating out range codes based on amplitude levels.

10. The method of claim 1 wherein the step of detecting one or more targets comprises a step of extracting a unique target.

11. The method of claim 1 wherein the step of detecting one or more targets comprises a step of estimating range and speed of the target without resorting to a co-operative exchange of data.

12. The method of claim 1 wherein the PDMA uses a spread spectrum technique.

13. The method of claim 1 wherein the PDMA uses a Code Division Multiple Access (CDMA) Amplitude Shift Keying (ASK) modulation.

14. The method of claim 1 wherein the PDMA uses a radio frequency identification (RFID) protocol.

15. The method of claim 1 wherein the PDMA uses a time hopping

technique of an Ultra Wideband (UWB).

16. The method of claim 1 wherein the step of making an alert makes a visual alert.
17. The method of claim 1 wherein the step of making an alerting makes an audio alert.
18. An apparatus for avoiding collisions comprising:
 - a transmitter for transmitting a signal processed by a Pulse Division Multiple Access (PDMA) protocol;
 - a receiver for receiving one or more target signals processed by the PDMA protocol and extracting a target signal; and
 - a control processor for transmitting and receiving the PDMA protocol and for providing an alert for collision avoidance based on the target signal.
19. The apparatus of claim 18 wherein the control processor generates PN codes for Amplitude Shift Keying (ASK) and time-hopping, the transmitter transmits PN code sequences which are produced by the ASK and time-hopping.
20. The apparatus of claim 19 wherein the transmitter includes a circuit for creating range codes using the ASK and a circuit for time-hopping a chip which is a slice of the range code.
21. The apparatus of claim 20 wherein the receiver includes a circuit for reversing the time-hopping of the received signal, a circuit for separating out range codes based on amplitude levels, and a circuit for extracting a unique range code to determine which of the range codes are present

22. The apparatus of claim 21 wherein the transmitter includes a voltage controlled PLL for generating carrier for radio transmission, a time delay buffer for time-hopping the carrier and an amplifier for generating chips by switching the time-hopped carrier, and the control processor controls the voltage controlled PLL, the time delay buffer and the amplifier.

23. The apparatus of claim 22 wherein the receiver includes a despreader for reversing the time hopping of the received carrier chips, a adaptive squelch circuit for separating the received range codes based on amplitudes levels and a sliding correlator for locking onto each of range codes based on control of the control processor.

24. The apparatus of claim 18 wherein the transmitter includes a circuit for creating range codes and a circuit for time-hopping a chip which is a slice of the range code, and the receiver includes a circuit for reversing the time hopping and a circuit for separating out range codes to determine which of the range codes are present, and the control processor controls creating circuits, time-hopping circuits, reversing circuit and separating circuits.

25. The apparatus of claim 18 wherein said control processor control the transmitter for generates pseudo-random noise (PN) codes.

26. The apparatus of claim 18 wherein said transmitter includes means for sending PN code sequences.

27. The apparatus of claim 18 wherein said transmitter includes a voltage controlled oscillator for generating a carrier for radio transmission.

28. The apparatus of claim 27 wherein said transmitter includes a time delay buffer for time-hopping the carrier.

29. The apparatus of claim 28 wherein said transmitter includes an amplifier for generating chips by switching the time-hopped carrier on and off.

30. The apparatus of claim 26 wherein said receiver includes mean for disspreading the PN codes and further means for extract a subset of PN sequence based on the amplitude level.

31. The apparatus of claim 18 wherein said receiver includes a low noise amplifier for amplifying a received weak signal.

32. The apparatus of claim 29 wherein said receiver includes a time delay despreaders for reversing a time hopping of the received carrier chips.

33. The apparatus of claim 18 wherein said receiver includes a mixer for converting a high frequency of the received signal to a lower intermediate frequency (IF).

34. The apparatus of claim 18 wherein said receiver includes an IF filter for filtering the received signal.

35. The apparatus of claim 29 wherein said receiver includes an adaptive squelch IF amplifier for separating out a plurality of carrier amplitudes by slicing the amplitude levels.

36. The apparatus of claim 18 wherein said receiver includes an IF filter for converting an IF signal into a logic level data signal.

37. The apparatus of claim 18 wherein said receiver includes a sliding correlator for locking onto each of the plurality of carrier amplitudes.

38. The apparatus of claim 18 wherein said control processor includes means for estimating range and speed of a target corresponding to the target signal.

39. The apparatus of claim 18 further comprising a phase locked loop for generating multiple timing frequencies.

40. The apparatus of claim 18 wherein the control processor detects one or more targets based on the received signals which includes a signal output from a Global Positioning Satellite (GPS) receiver.

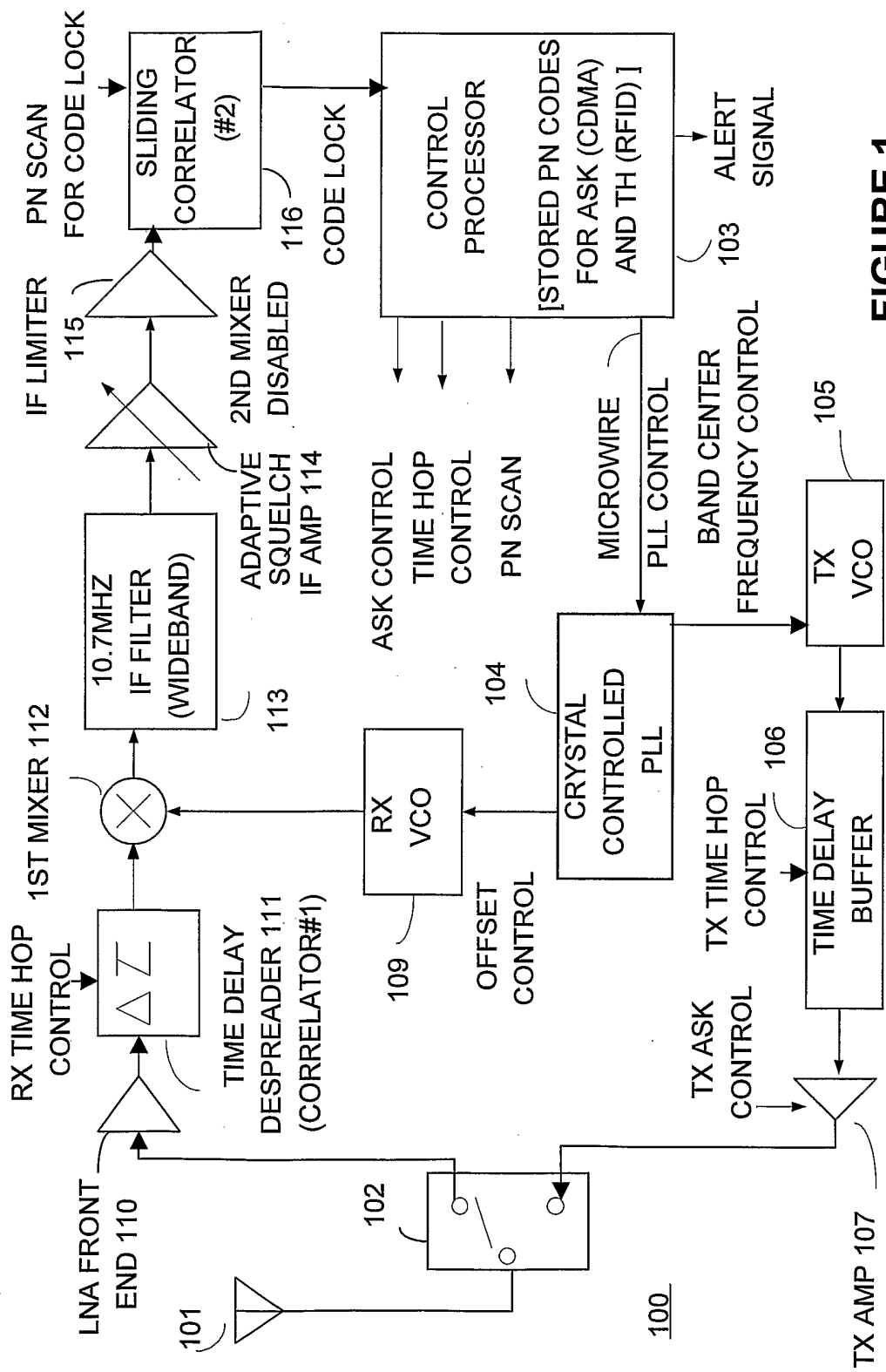


FIGURE 1

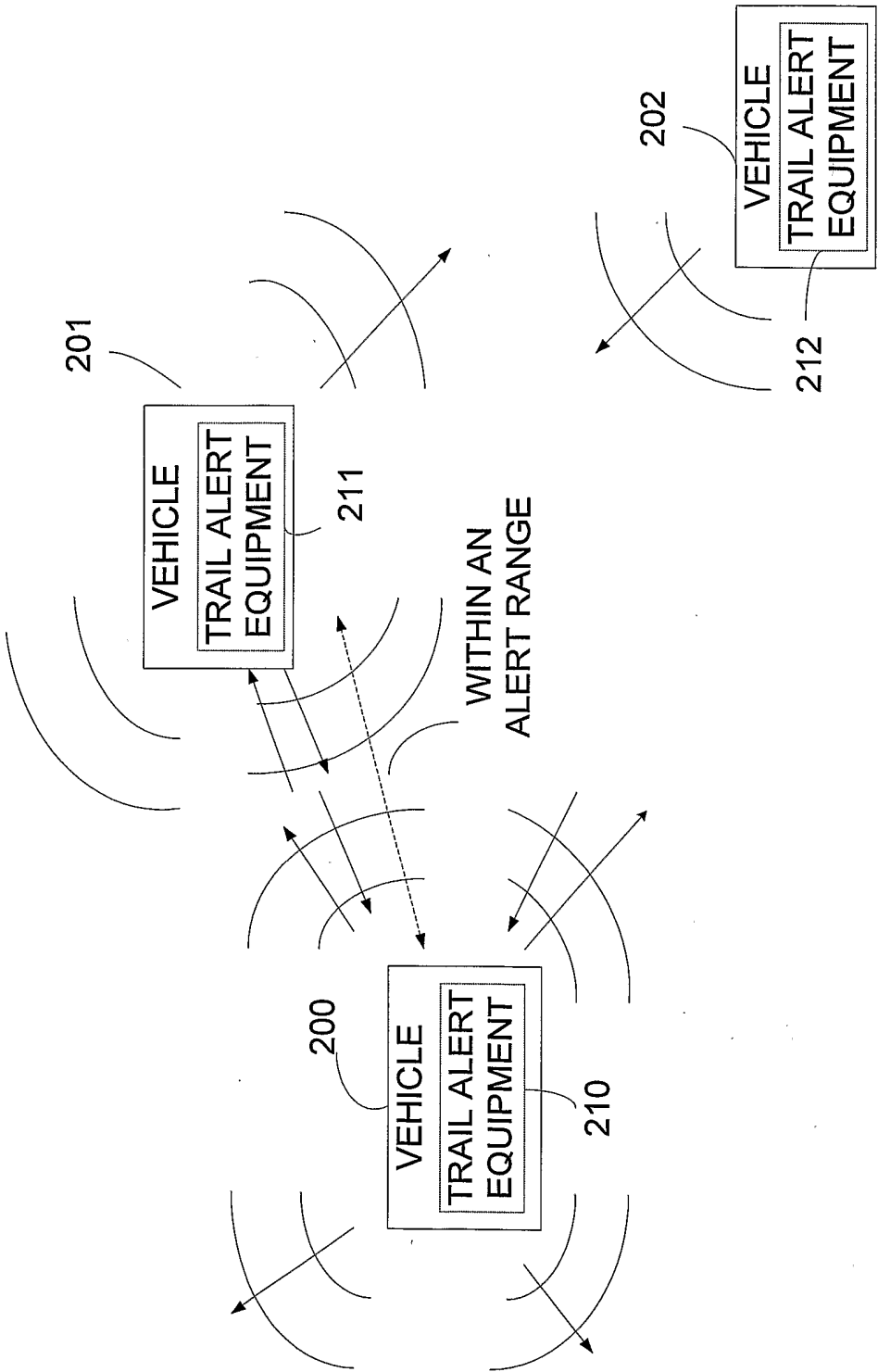


FIGURE 2

INTERNATIONAL SEARCH REPORT

Inte nal Application No

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G08G5/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G08G G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 96 05562 A (WORLDWIDE NOTIFIC SYST) 22 February 1996 (1996-02-22) figure 1 page 7, line 24-35 page 27, line 13-35	1-40
Y	WO 88 09027 A (DUNLAVY JOHN HAROLD) 17 November 1988 (1988-11-17) page 3, paragraphs 1,5 page 4, paragraph 5	1-40
A	WO 00 79502 A (MARK MARION RUSSELL ;COMMW SCIENT IND RES ORG (AU)) 28 December 2000 (2000-12-28) figure 4 page 2, line 5-20 page 3, line 1-15	1,18

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Further documents are listed in the continuation of box C.

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Patent family members are listed in annex.

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Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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