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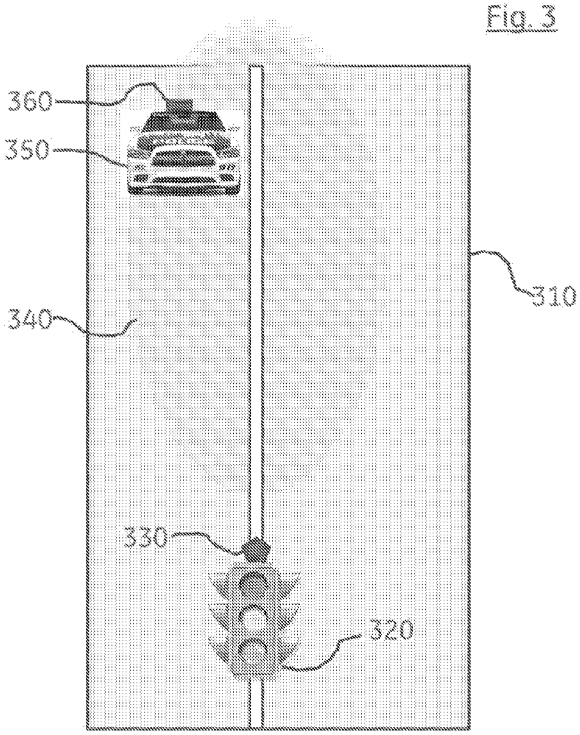
(54) Title: EMERGENCY VEHICLE ALERT SYSTEM

Fig. 3



(57) Abstract: A method and system for the control and signaling of traffic signal lights by emergency vehicles in the vicinity. Emergency vehicles can be detected by traffic signal lights allowing the emergency vehicle to have a prioritized, rapid, unimpeded, and safe emergency vehicle transit.

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(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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EMERGENCY VEHICLE ALERT SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a non-provisional of and claims the benefit of U.S. Provisional Patent Applications Serial Nos. 61/907,069, 61/907,078, 61/907,090, 61/907,114, 61/907,133, 61/907,150, 61/907,168, 61/907,188 and 61/907,210 filed on November 21, 2013, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] Traffic volume continues to increase in urban areas. This ever increasing volume of traffic continues to impede emergency vehicle transits in an already crowded city. One very important capability for emergency responders piloting a vehicle through a city is the ability to control a traffic light directly in their path. Many systems involving communications have been proposed to instantiate this capability but they are all subject to various problems including interference and the need for periodic maintenance of some of the vehicle electronics.

[0003] There is therefore a need for a system that is robust to interference, does not require periodic maintenance, such as the replacement of batteries, and does not require a significant effort on the part of the emergency responders to control the traffic lights, and is, majorly decentralized.

SUMMARY

[0004] A traffic light control system and method wherein a traffic signal is capable of generating and transmitting a signal within a frequency band of 57-64 GHz and a receiver capable of receiving a response to the signal. A computational device is contained within the traffic signal that is communicatively coupled to the receiver to provide processing capabilities that analyze the response to the signal to determine if a specified condition is present.

BRIEF DESCRIPTION OF THE ILLUSTRATIONS

[0005] FIG. 1 is a graph of millimeter wave atmospheric attenuation.

[0006] FIG. 2 is a portion of the graph of Fig. 1.

[0007] FIG. 3 illustrates the transponding scenario according to one embodiment.

[0008] FIG. 4 illustrates the power spectral density of a DS spread spectrum signal.

[0009] FIG. 5 An embodiment of the passive transponder.

DETAILED DESCRIPTION

[0010] A suitable electromagnetic spectrum for use in the US for enabling the emergency vehicle alert system has been made available by the spectrum allocation of 57-64 GHz for unlicensed operation. This very large contiguous portion of the electromagnetic spectrum has excellent attributes for enabling an emergency vehicle to control a traffic control system. In an embodiment, a passive transponder carried by the emergency vehicle is enabled to reflect signals within the available spectrum allocation of 57-64 GHz back to the source of the signals indicating that an emergency vehicle is in the vicinity. The source may be a traffic signal that is a self-contained localized traffic control system. The system does not necessarily need to rely on a centralized traffic control infrastructure; however, systems that coordinate the local traffic control systems with centralized traffic control systems are envisioned.

[0011] FIG. 1 is taken from "Millimeter Wave Propagation: Spectrum Management Implications" published by the FCC as Bulletin Number 70, July, 1997. The figure shows the remarkable attenuation of electromagnetic energy in the atmosphere. Curve A is for sea level with temperature at 20°C, pressure at 760 mm, and water content at 7.5 gm/cubic meter (75% humidity); curve B is for an altitude of 4 km above sea level with temperature at 0°C and water content at 1 gm/cubic meter (relatively dry air). FIG. 2 is an extract of FIG. 1 emphasizing a frequency range comprising the unlicensed spectrum and showing the frequency selective attenuation due primarily to oxygen.

[0012] As seen in Figures 1 and 2, there is relatively a high attenuation that occurs with distance for the millimeter wave frequency spectrum of 57-64 GHz. This high attenuation can work towards reducing interference from other sources, limit the number of potentially interfering transponders and provide clutter rejection. The amount of bandwidth available within the spectrum allocation of 57-64 GHz for the system to use is 7 GHz wide, a significant amount of spectrum. There are very many modulation and protocol schemes for performing transponding activity.

[0013] The passive transponder taught herein may be a device that may mounted on the top of the emergency vehicle. The passive transponder may include of a pair of corner reflectors, spaced apart by a distance D and oriented to maximize the radar cross section for millimeter wave RF signals incident upon the corner reflectors. In an embodiment, the orientations of the reflectors is designed to reflect millimeter wave RF signal incident from the direction in which the emergency vehicle is proceeding.

[0014] Fig. 3 diagrams an example scenario. A police car 350 is proceeding on a street 310 towards a traffic signal 320. The traffic signal 320 has an antenna 330 capable of transmitting interrogation signals and receiving reflected portions of those interrogation signals. The antenna 330 may be mounted on top of the traffic signal 320 and is operatively connected to transmitter and receiver apparatus that is contained within the traffic signal 320. The antenna 330 may be configured to interrogate a device by transmission of an interrogation signal within the spectrum allocation of 57-64 GHz that may be received by a targeted device. The targeted device that receives the interrogation signal may respond to the reception in one of many ways in accordance with varying embodiments. In an embodiment, the targeted device may be a passive transponder 360. FIG. 3 shown a police car 350 with a passive transponder 360 mounted on top of the police car 350. The passive transponder 360 is enabled by traffic signal 320 sending an interrogation signal that is reflected by the passive transponder 360. Portion of the reflected interrogation signal is received by the traffic signal 302. Computational elements within the traffic signal 320 can perform signal processing on the received portions of the reflected interrogation signal. The antenna pattern interrogation signal transmitted by the traffic signal 320 is represented as the shaded area 340.

[0015] The passive transponder 360 mounted atop the police car may include a pair of erected corner reflectors separated by a distance D. Therefore, the reflector further towards the back of the police car 350 will receive the same interrogation signal received by the reflector towards the front of the police car 350 but delayed by D/c, where c is the speed of light.

[0016] As an example, and not by way of limitation, the interrogation signal transmitted by the traffic signal 320 may be a simple bi-phase coded, direct sequence (DS), spread spectrum signal. A common technique is to build a periodic, spread spectrum signal, where $s(t)$ denotes one period of the periodic, spread spectrum signal. The periodic spread spectrum signal is formed by selecting a segment T-time units long of a sine wave of many periods that is multiplied by a sequence of chips, which are plus and minus ones.

[0017] In an embodiment, the sequence of chips within the interrogation signal may be chosen to have an autocorrelation characterized by a sharp spike around the zero-offset point of the autocorrelation and low magnitude sidelobes. The specific sequence of chips will be detectable by processing performed by a computational device contained within the traffic signal 320. The processing may detect the autocorrelation spikes within the reflected portions of the interrogation signal by cross-correlating the interrogation signal against the received signal which is the reflected portions of the interrogation signal.

[0018] In another embodiment, the sequence of chips within the interrogation signal may be chosen to have a low maximum absolute value of cross-correlation with other DS signals operating in the 57-64 GHz spectrum in order to avoid significant interference to and from the other DS signals operating in the 57-64 GHz spectrum.

[0018] In another embodiment, the interrogation signal has sequence of plus and minus ones of the chips and the segment of the sine wave of many periods aligned so that transition times of the sequence of plus and minus ones align with zero crossings of the segment of T-time unit is long of the sine wave of many periods. The interrogation signal formed for this example is built by concatenating one or more periods of $s(t)$.

[0019] Fig. 4 sketches the power spectral density 410 of the main lobe of the periodic spread spectrum signal with chip width cw. The main lobe is symmetric about the center frequency f_c, and spans the frequency range $f_c - \frac{1}{cw}$ to $f_c + \frac{1}{cw}$. The main lobe comprises about 90% of the signal's power. For example, a chip rate of 3.5 gigachips per second with center frequency at 60.5 GHz spreads the signal's main lobe across the entire unlicensed band. The spreading chips, a deterministic but pseudorandom sequence of binary values, will spread the signal energy approximately uniformly over the main lobe. At a signaling rate of 3.5 gigachips per second, there are 11.667 chips per meter. If D, for example, is chosen to be 0.3 meters, then the reflection from the reflector towards the back of the police car will be 7 chips delayed from the reflection from the reflector towards the front of the police car.

[0020] In an embodiment, the receiver associated with the traffic signal 320 may be operatively coupled to a computational device within the traffic signal 320 that continuously cross-correlates a period of the interrogation signal against the received signal and stacks the processed returns. The stacking forms an average of the cross-correlations by periodically summing their successive overlays and results in noise mitigation of the cross-correlation so that two cross-correlation spikes, spaced by 7 chip times, will rise out of the clutter and noise. The cross-correlation spikes signify the presence of a transponding emergency vehicle in the vicinity allowing computational elements within the traffic light to set a state of a transponding emergency vehicle. In an embodiment, the state of a transponding emergency vehicle may cause the traffic light to enter an emergency mode. In an embodiment, the emergency mode may be simply turning traffic signals in every direction to red.

[0021] In an embodiment, computational elements may perform system processing to estimate the emergency vehicle's position, direction and/or speed. Embodiments are envisioned wherein emergency the emergency vehicle's location, speed and direction are recorded and/or reported to a central control system.

[0022] To better overcome clutter and increase the probability of detection while decreasing the probability of a false alarm, an embodiment may use circularly polarized transmissions having circularly polarized antennas with low axial-ratios. In an embodiment, the corner reflectors are specifically dimensioned. An appropriate model for the corner reflector's role is through a radar formulation. The maximum radar cross section (RCS), σ, of a triangular corner reflector, with common edge length L, is $\sigma = \frac{4\pi L^4}{3 \cdot \lambda^2}$ where λ is the wavelength.

[0023] In an embodiment, if an emergency responder, such as a police officer in a police car, wishes to enable the passive transponder and thereby enable the emergency vehicle to respond to a traffic light's interrogation and enter its emergency mode, the emergency responder may manually enable the passive transponder. This may be done in many ways. In one embodiment, an emergency responder releases a mechanical latch that causes the reflectors to erect so that they reflect electromagnetic energy arriving at the vehicle's front. [0024] In another embodiment the emergency responder pulls down a ring that is attached to a metallic plate as illustrated in FIGS. 5A and 5B.

[0025] In embodiments shown by these illustrations the passive transponder is located in an electromagnetically transparent housing 510 that affords the passive transponder some shelter from the elements such as winds and rain. A pair of substantially identical corner reflectors 520 and 530 is mounted so that their centers are separated by distance D along a line oriented towards the traffic light's interrogator.

[0026] In an embodiment, the corner reflectors may be positioned so that the rear reflector, the reflector furthest from the front of the policed car, is not significantly shadowed by the other reflector. In FIGS. 5A and 5B, the rear reflector is located at a higher position than the other reflector.

[0027] In an embodiment, a piece of RF millimeter wave opaque material 540 is located in front and across the aperture of the corner reflector 520. When the material 540 is so located, there will be no significant reflection from corner reflector 520. To enable the passive transponder, the piece of material 540 is pulled out of the way by pulling on an attached ring 550.

[0028] In another embodiment, the passive transponder may be activated by a motorized mechanical means.

[0029] Other embodiments may provide for a more automated activations of transponders in emergency vehicles. For example in one embodiment, the occurrence of an event, such as the siren being used or blinking lights being activated, may in turn activate the transponder. In another embodiment, the transponder may be activated by a mechanism such as a switch inside the emergency vehicle.

[0030] While only certain features of the invention have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

[0031] In another embodiment, some systems will handle and haul communications for other infrastructure systems. These messages may require a higher standard of care ensuring delivery or notification of non-delivery. When the streetlight optical signaling network is handling these messages, it may invoke a packet-handling protocol with strict accountability for assuring delivery and initiating retransmissions as required.

[0032] An exemplary technical effect of the methods and systems described herein includes: (a) generating a melt pool based on the build parameters of the component; (b) detecting an optical signal generated by the melt pool to measure the size or the temperature of the melt pool; and (c) modifying the build parameters in real-time based on the size or the temperature of the melt pool to achieve a desired physical property of the component.

[0033] Some embodiments involve the use of one or more electronic or computing devices. Such devices typically include a processor or controller, such as, without limitation, a general purpose central processing unit (CPU), a graphics processing unit (GPU), a microcontroller, a field programmable gate array (FPGA), a reduced instruction set computer (RISC) processor, an application specific integrated circuit (ASIC), a programmable logic circuit (PLC), and/or any other circuit or processor capable of executing the functions described herein.

[0034] The methods described herein may be encoded as executable instructions embodied in a computer readable medium, including, without limitation, a storage device, and/or a memory device. Such instructions, when executed by a processor, cause the processor to perform at least a portion of the methods described herein. The above examples are exemplary only, and thus are not intended to limit in any way the definition and/or meaning of the term processor.

[0035] Exemplary embodiments for enhancing the build parameters for making additive manufactured components are described above in detail. The apparatus, systems, and methods are not limited to the specific embodiments described herein, but rather, operations of the methods and components of the systems may be utilized independently and separately from other operations or components described herein. For example, the systems, methods, and apparatus described herein may have other industrial or consumer applications and are not limited to practice with electronic components as described herein. Rather, one or more embodiments may be implemented and utilized in connection with other industries.

[0036] Although specific features of various embodiments of the invention may be shown in some drawings and not in others, this is for convenience only. In accordance with the principles of the invention, any feature of a drawing may be referenced or claimed in combination with any feature of any other drawing.

[0037] This written description uses examples to disclose the invention, including the best mode, and to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

Claims

1. A traffic light control system comprising:

at least one traffic signal apparatus;

a signal generator, contained within the traffic signal apparatus, that generates a signal within a frequency band of 57-64 GHz;

a transmitter, contained within the traffic signal apparatus, that transmits the signal;

a receiver, contained within the traffic signal apparatus, that receives a response to the signal; and

a computational device, contained within the traffic signal apparatus, communicatively coupled to the receiver that analyzes the response to the signal to determine if a specified condition is present.

2. The traffic light control system of claim 1 wherein the computational device sets an emergency mode for the traffic signal if the specified condition is present.

3. The traffic light control system of claim 1 wherein the signal generator generates a direct sequence spread spectrum signal with a main lobe that occupies a majority of the 57-64 GHz band.

4. The system of claim 1 wherein the response received is a reflection of the transmitted signal.

5. The traffic light control system of claim 4 further comprising a pair of erected reflectors separated by a distance D, said pair of erected reflectors generating the reflection.

6. The traffic light control system of claim 5 wherein the computational device processes the reflection by continuously cross-correlating the transmitted signal against the received response and stacking the cross-correlations.

7. The traffic light control system of claim 6 wherein the specified condition is the presence of two spikes in the stacked cross-correlations wherein the spikes are separated in time by twice the distance D divided by the speed of light.

8. The traffic light control system of claim 1 wherein the specified condition is a sharp spike around a zero-offset point of an autocorrelation and low magnitude sidelobes.

9. The traffic light control system of claim 1 wherein the specified condition is a sequence of plus and minus ones within reflected portions of the signal and a segment within the signal having a sine wave of many periods is aligned so that transition times of the sequence of plus and minus ones align with zero crossings of the sine wave within the segment.

10. The traffic light control system of claim 1 wherein the response is generated by an emergency vehicle in response to the emergency vehicle receiving the signal.

11. A method for traffic light control comprising:

equipping at least one traffic signal with a signal generator;

generating a signal within a frequency band of 57-64 GHz;

transmitting the signal;

receiving a response to the signal;

further equipping the at least one traffic signal with a computational device for processing the received response;

processing the response to determine if a specified condition is present; and

controlling the at least one traffic signal on determining the presence of the specified condition.

12. The method of claim 11 wherein generating the signal within a frequency band of 57-64 GHz further comprises generating a direct sequence spread spectrum signal with a main lobe occupying a majority of the 57-64 GHz band.

13. The method of claim 11 wherein controlling further comprises setting an emergency mode for the traffic signal if the processing of the response determines the presence of the specified condition.

14. The method of claim 11 wherein receiving the response further comprises receiving a reflection of the transmitted signal.

15. The method of claim 14 further comprising erecting a pair of reflectors on an emergency vehicle wherein the reflectors are separated by a distance D, said pair of reflectors generating the reflection.

16. The method of claim 15 wherein processing further comprises processing the reflection by the computational device to continuously cross-correlate the transmitted signal against the received response and stacking cross-correlations.

17. The method of claim 16 wherein processing further comprises determining the presence of the specified condition by revealing the presence of two spikes in stacked cross-correlations wherein the spikes are separated in time by twice the distance D divided by the speed of light.

18. The method of claim 14 wherein processing further comprises determining if the specified condition is met within the reflection, wherein the specified condition is a sequence of plus and minus ones within reflected portions of the signal and a segment within the signal having a sine wave of many periods is aligned so that transition times of the sequence of plus and minus ones align with zero crossings of the sine wave within the segment.

19. The method of claim 18 wherein processing further comprises processing the reflection to continuously decorrelate and incoherently stack processed returns of the reflection to identify correlation spikes spaced by a predetermined number of chip times.

20. The method of claim 11 wherein the response is generated by an emergency vehicle in response to the emergency vehicle receiving the signal.

EMERGENCY VEHICLE ALERT SYSTEM

Fig. 1

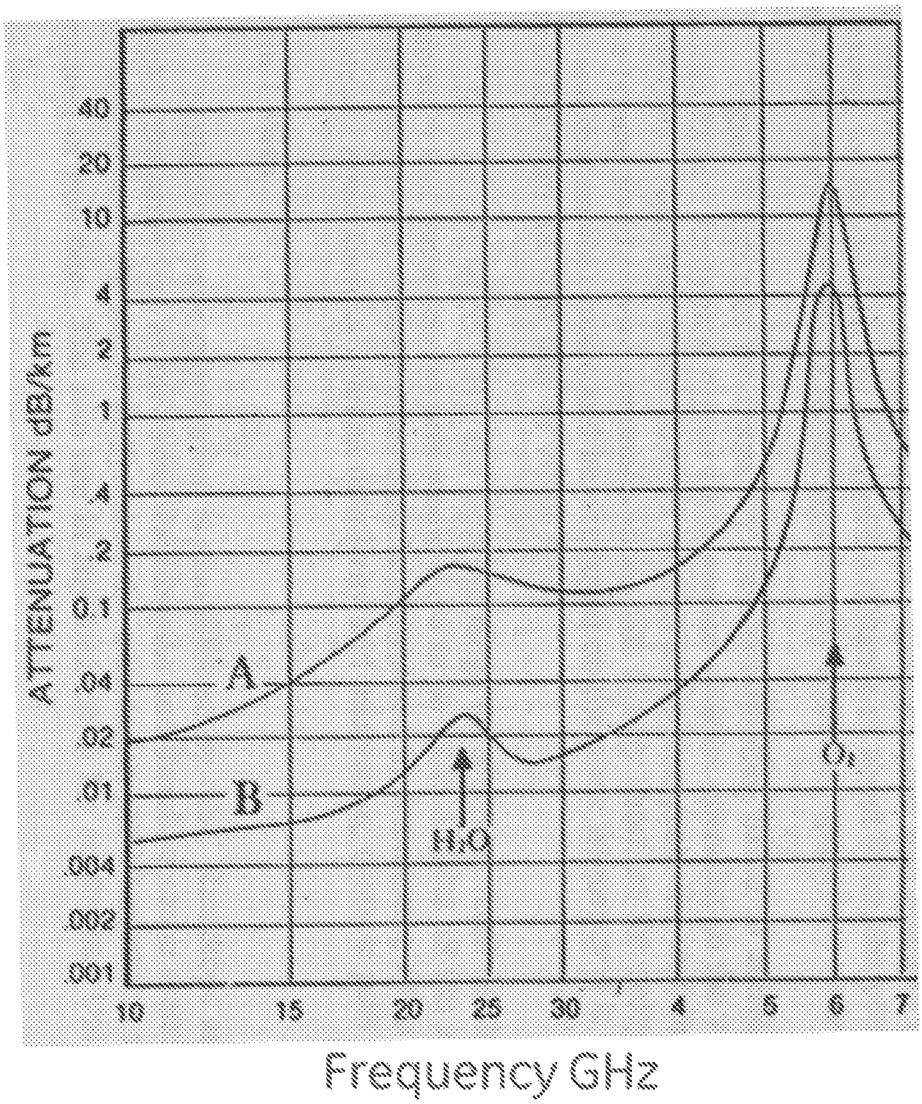


Fig. 2

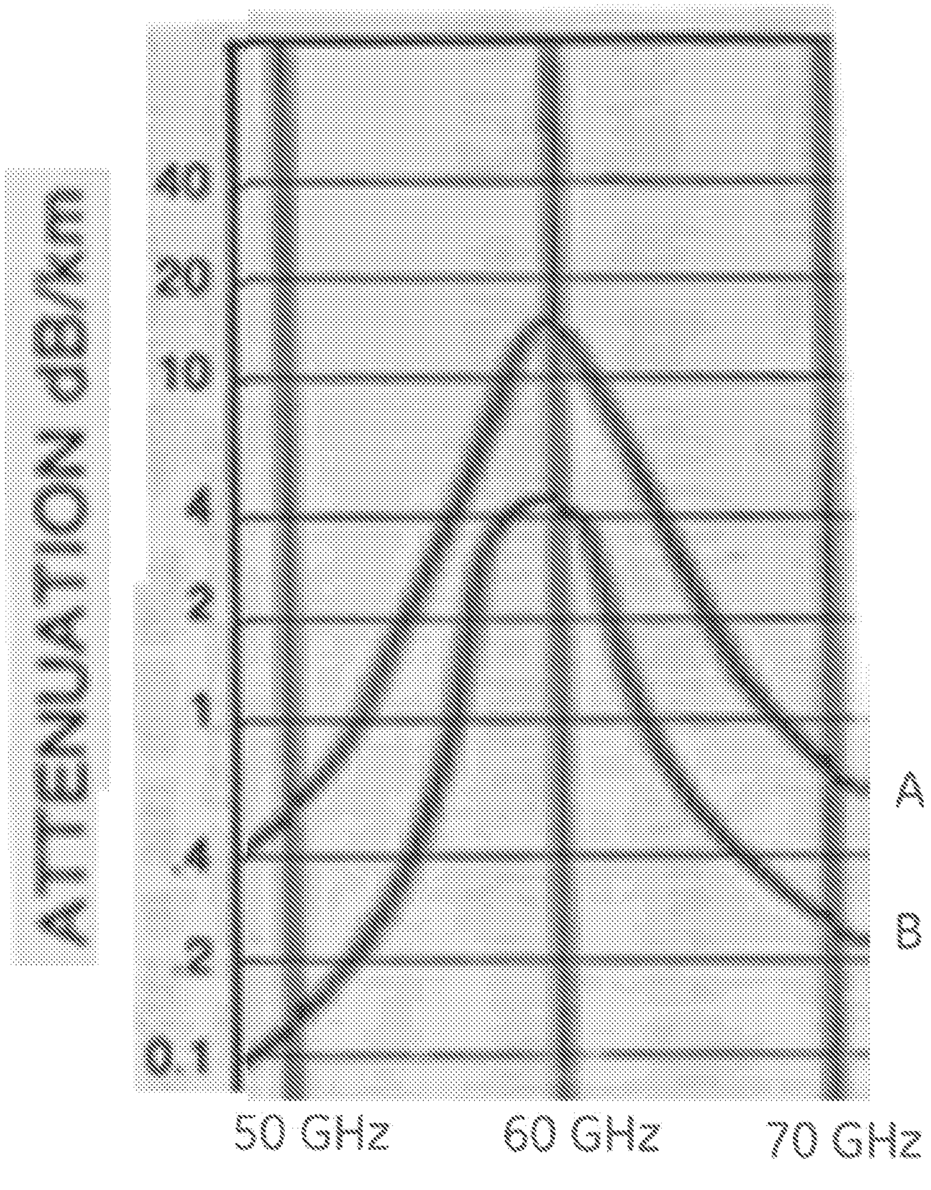


Fig. 3

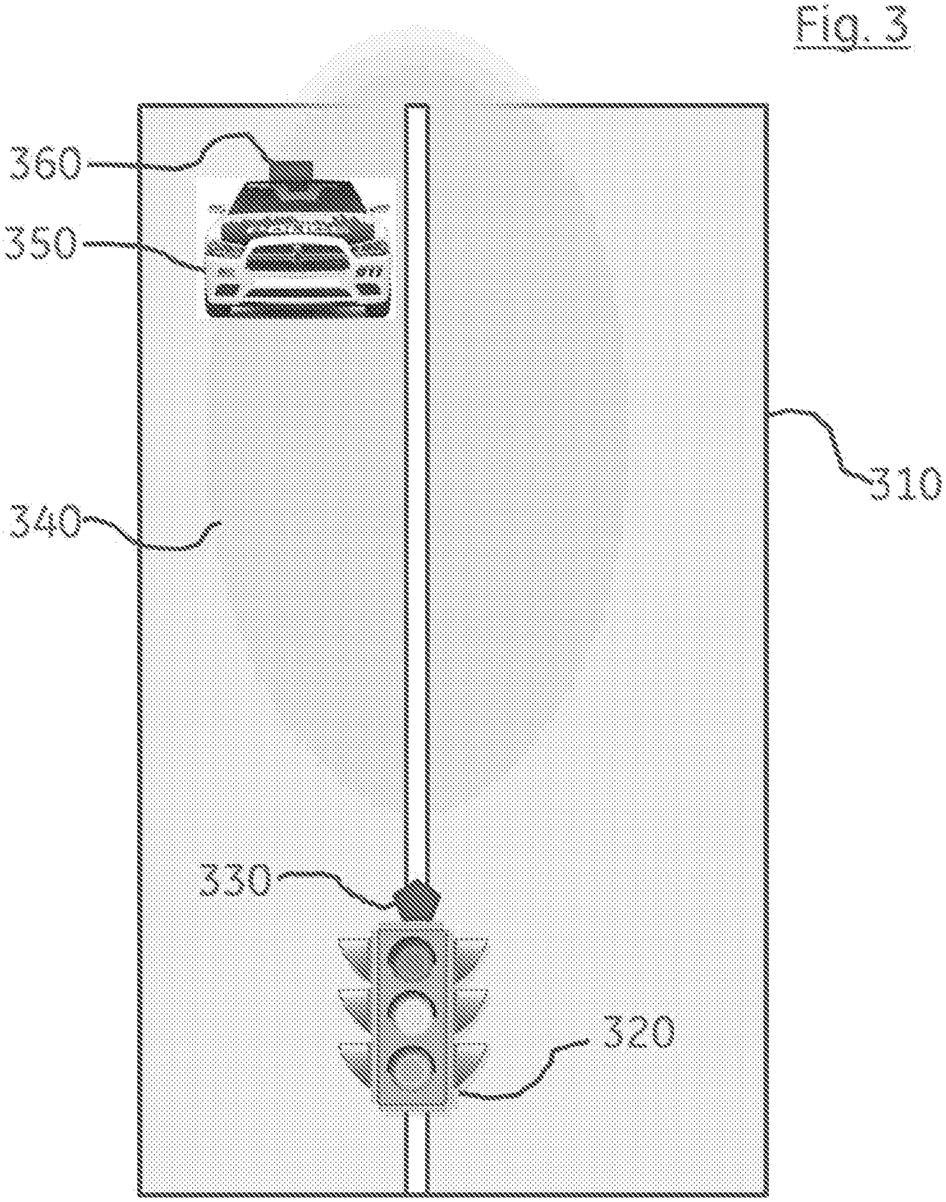


Fig. 4

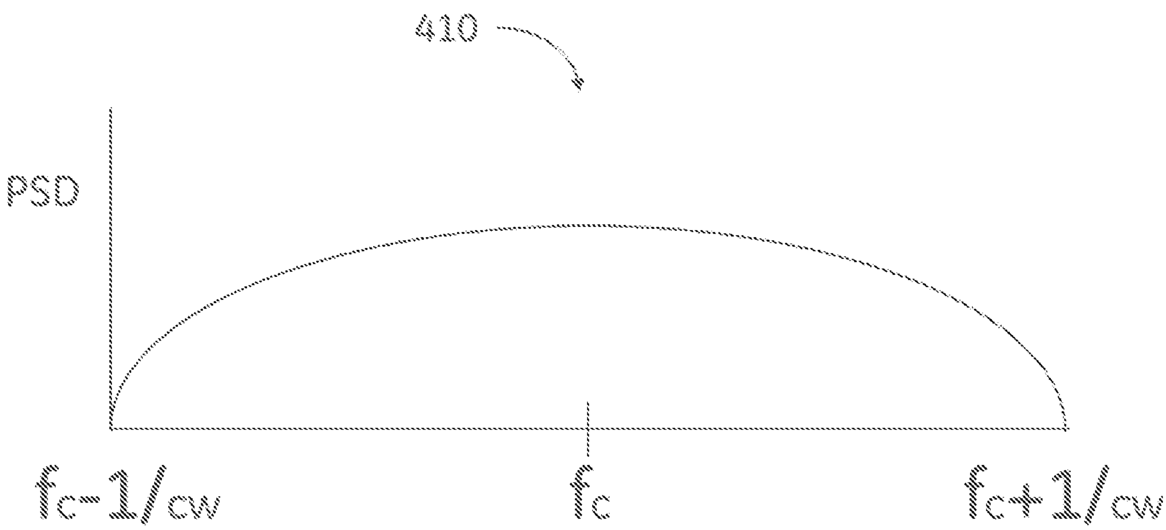
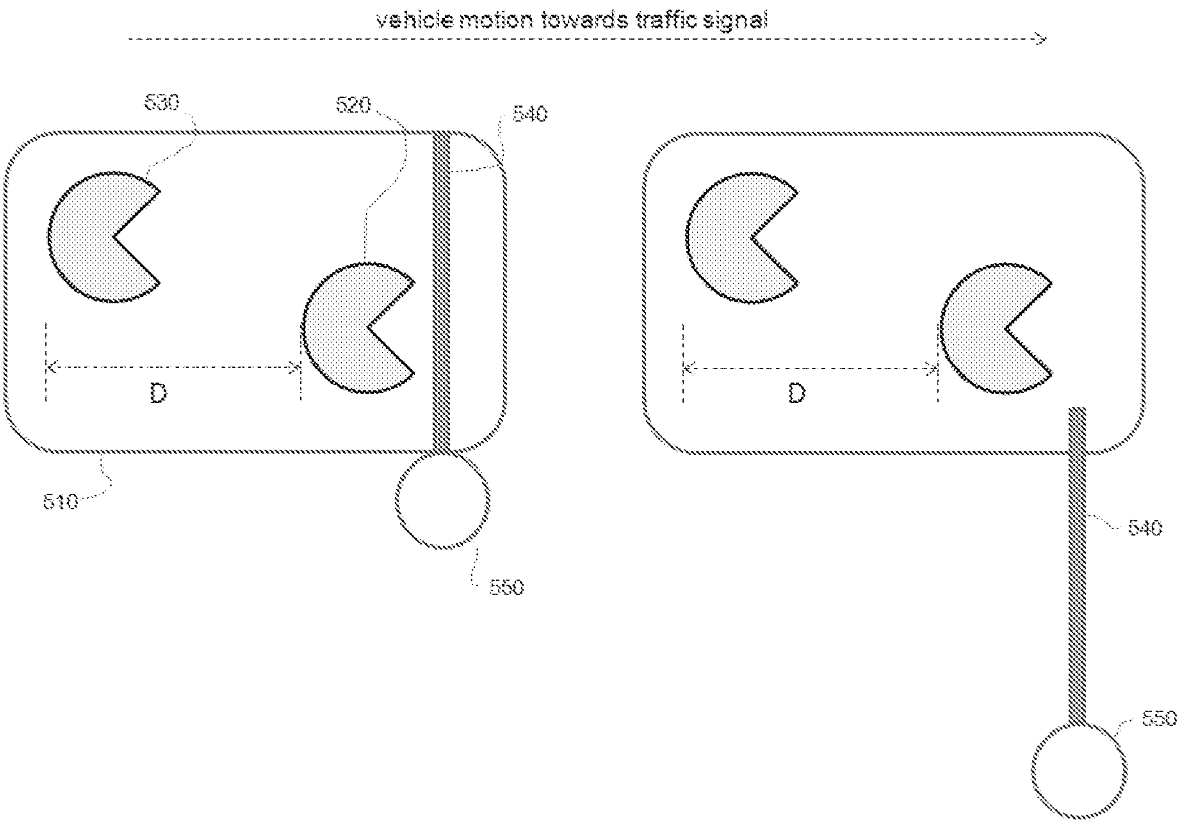


FIG. 5A FIG. 5B


vehicle motion towards traffic signal
530
520
540
D
510
550
D
540
550

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/066917

A. CLASSIFICATION OF SUBJECT MATTER

G08G 1/0965(2006.01)i

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)
G08G 1/0965; G08F 19/00; G08G 1/095; G08G 1/07; B60Q 1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: traffic light, emergency vehicle, control, alert, response

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5014052 A (OBECK) 07 May 1991 See column 5, lines 28-57, column 6, lines 36-49, column 7, lines 20-23, claims 1, 17-18 and figure 5.	1-20
A	US 5345232 A (ROBERTSON) 06 September 1994 See abstract, claims 1-3 and figures 4-7.	1-20
A	KR 10-2006-0102552 A (CALIFORNIA INSTITUTE OF TECHNOLOGY) 27 September 2006 See claims 1-10 and figures 2-9.	1-20
A	US 7248149 B2 (BACHELDER et al.) 24 July 2007 See figures 1-2.	1-20
A	US 4704610 A (SMITH et al.) 03 November 1987 See figures 1-7.	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 March 2015 (05.03.2015)	**05 March 2015 (05.03.2015)**

Name and mailing address of the ISA/KR
International Application Division
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5014052 A	07/05/1991	None	
US 5345232 A	06/09/1994	None	
KR 10-2006-0102552 A	27/09/2006	AU 2004-275339 A1	31/03/2005
		AU 2004-321277 A1	12/01/2006
		AU 2005-228163 A1	13/10/2005
		CA 2538302 A1	31/03/2005
		CN 1867953 A	22/11/2006
		EP 1665196 A2	07/06/2006
		EP 1665196 A4	03/10/2007
		EP 1695316 A2	30/08/2006
		JP 2007-506161 A	15/03/2007
		US 2005-0104745 A1	19/05/2005
		US 2005-0128103 A1	16/06/2005
		US 2006-0261977 A1	23/11/2006
		US 2007-0040700 A1	22/02/2007
		US 2008-0316055 A1	25/12/2008
		US 2009-0189782 A1	30/07/2009
		US 6940422 B1	06/09/2005
		US 7098806 B2	29/08/2006
		US 7327280 B2	05/02/2008
		US 7864071 B2	04/01/2011
		US 7868783 B2	11/01/2011
		WO 2005-029437 A2	31/03/2005
		WO 2005-029437 A3	16/03/2006
		WO 2005-094544 A2	13/10/2005
		WO 2005-094544 A3	13/07/2006
		WO 2006-004565 A2	12/01/2006
		WO 2006-004565 A3	22/06/2006
		WO 2007-022134 A2	22/02/2007
		WO 2007-022134 A3	06/12/2007
US 7248149 B2	24/07/2007	US 2005-116838 A1	02/06/2005
		WO 2005-036494 A2	21/04/2005
		WO 2005-036494 A3	21/09/2006
US 4704610 A	03/11/1987	JP 62-140198 A	23/06/1987
		US 4704610 A	03/11/1987
		US 4775865 A	04/10/1988