(54) Title: SYSTEM AND METHOD FOR SMARTPHONE COMMUNICATION BETWEEN VEHICLE AND PEDESTRIAN

FIG. 9

900

Start

Set Criteria

Set Thresholds

Generate Vector Information

Receive Vector Information

Imminent Collision?

Yes

Provide Signal

S918

No

S914

Phone Off?

Yes

Stop

S916

S912

S908

S904

S906

S902

(57) Abstract: A device is provided that includes a criteria setting component, a threshold setting component, a position determining component, a velocity determining component, a vector its formation receiving component, a collision determining component and a signal component. The criteria setting component establish criterion to filter unlikely collisions. The threshold setting component establishes a threshold associated with the criterion. The position determining component determines a position. The velocity determining component determines a velocity. The vector information receiving component receives vector information associated with a communication device. The collision determining component determines a likelihood of collision. The signal component provides a warning associated with the likelihood of collision.
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BACKGROUND

[0001] There currently is no system for smartphones to autonomously communicate with one another. It would be beneficial if a smartphone could determine aspects of the vehicle with which it is disposed and communicate these aspects to smartphones in nearby vehicles or on nearby pedestrians to reduce the likelihood of collisions or other unsafe conditions. Such a technology is today not commercially available.

SUMMARY

[0002] The present invention provides an improved method and apparatus for determining aspects of a vehicle within which a smartphone is disposed and for communicating these aspects to nearby smartphones reduce the likelihood of vehicular collisions.

[0003] Various embodiments described herein are drawn to a device for use with a vehicle and with a communication device. The communication device can transmit a first vehicle mode signal and a subsequent signal. The device includes a processing component, an indicator component, a transmitting component and a receiving component. The processing component can operate in a vehicle mode and can operate in a second mode. The indicator component can provide a vehicle mode indication signal when the processing component is operating in the vehicle mode. The transmitting component can transmit a second vehicle mode signal based on the vehicle mode indication signal. The receiving component can receive the first vehicle mode signal and can receive the subsequent signal. The processing component can further perform a function while in the vehicle mode based on the first vehicle mode signal and the subsequent signal.
BRIEF SUMMARY OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of the specification, illustrate an exemplary embodiment of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

FIGS. 1A-C illustrate two vehicles travelling at times $t_o$, $t_i$, and $t_f$, respectively, and ultimately crashing;

FIG. 2 illustrates a communication system;

FIGS. 3A-C illustrate two vehicles travelling at times $t_4$, $t_4$, and $t_5$, respectively, and avoiding a crash in accordance with aspects of the present invention;

FIG. 4 illustrates an example communication device in accordance with aspects of the present invention;

FIG. 5 illustrates an example parameter-detecting component in accordance with aspects of the present invention;

FIG. 6 illustrates an example method of communicating between two communication devices in accordance with aspects of the present invention;

FIG. 7A illustrates a person walking alongside a road at a time $t_i$;

FIG. 7B illustrates the person of FIG. 7A walking into the road at a time $t_f$;

FIG. 8 illustrates a communication system in accordance with aspects of the present invention;

FIG. 9 illustrates an example method of avoiding a collision between people by communicating between two communication devices in accordance with aspects of the present invention;

FIG. 10 illustrates an exploded view of an example embodiment of the controlling component of FIG. 4 in accordance with aspects of the present invention;

FIG. 11A illustrates an intersection at time $t_g$ implementing an example communication system in accordance with aspects of the present invention;
As used herein, the term "smartphone" includes cellular and/or satellite radiotelephone(s) with or without a display (text/graphical); Personal Communications System (PCS) terminals that may combine a radiotelephone with data processing, facsimile and/or data communications capabilities; Personal Digital Assistants (PDA) or other devices that can include a radio frequency transceiver and a pager, Internet/Intranet access, Web browser, organizer, calendar and/or a global positioning system (GPS) receiver; and/or conventional laptop (notebook) and/or palmtop (netbook) computer(s), tablet(s), or other appliance(s), which include a radio frequency transceiver. As used herein, the term "smartphone" also includes any other radiating user device that may have time-varying or feed geographic coordinates and/or may be portable, transportable, installed in a vehicle (aeronautical, maritime, or land-based) and/or situated and/or configured to operate locally and/or in a distributed fashion over one or more location(s).

In an example embodiment, a first smartphone is disposed in a first vehicle and a second smartphone is disposed in a second vehicle. The first smartphone and second smartphone are able to inform one another that they are each in a vehicle. The first smartphone is additionally able to inform the second smartphone of the speed and direction of the vehicle in which the first smartphone is disposed. In the event that the speed and direction of the vehicle in which the first smartphone is disposed may signify a probable collision with the vehicle in which the second smartphone is disposed, the second smartphone may provide a warning to the driver of the second vehicle.

Aspects of the present invention include a smartphone being able to identify whether it is in a vehicle based on a detection of a magnetic field and additional parameters associated with the vehicle.
Aspects of the present invention include a smartphone being able to associate a particular action to be performed when it receives information from another smartphone. In some specific embodiments, the particular function is based on whether the smartphone is disposed within a vehicle. As such, the number of possible functions to be performed is limited to those associated with being in a vehicle. Alternatively, if the smartphone is not disposed in a vehicle, than the number of possible functions to be performed is limited to those possible functions that are not associated with the smartphone being in a vehicle.

FIGs. 1A-C illustrate two vehicles travelling at times $t_1$ and $t_2$, respectively, and ultimately crashing.

FIG. 1A includes a vehicle 102 and a vehicle 104 at a time $t_1$. Vehicle 102 has a communication device 106 therein, and is traveling in a direction indicated by arrow 110; Vehicle 104 has a communication device 108 therein, and is traveling in a direction indicated by arrow 112. For purposes of discussion throughout, a smartphone is an example of a communication device.

At time $t_1$, the driver of vehicle 102 changes direction without seeing vehicle 104. This is shown in FIG. 1B. In particular, at time $t_1$, vehicle 102 is traveling in the direction indicated by arrow 114.

At time $t_2$, the driver of vehicle 102 continues to travel in the direction indicated by arrow 114 without seeing vehicle 104. This is shown in FIG. 1C, wherein vehicle 102 crashes with vehicle 104.

In accordance with aspects of the present invention, the situation discussed above with reference to FIGs. 1A-C may be avoided through use of nonverbal communications between two or more smartphones. This and other aspects of the present invention will be further described with reference to FIGs. 2-6.

FIG. 2 illustrates a communication system 200.

As shown in the figure, "communication system 200 includes a network 202, a communication device 204 in accordance with aspects of the present invention, a communication device 206 in accordance with aspects of the present invention, a plurality of computers - a sample of which is indicated as computer 208, a plurality of land-line."
telephones ~ a sample of which is indicated as land-Sine telephone 211 and a plurality of communication devices - a sample of which is indicated as communication device 212.

[0031] Network 202 may include wide area networks (WANs), local area networks (LANs), satellite communication networks, public switched telephone networks, cellular communication networks, the Internet and combinations thereof. Communication device 206 is able to send/receive information to/from network 202 via a communication channel 214. Communication device 206 is able to send/receive information to/from network 202 via a communication channel 216. Computer 208 is able to send/receive information to/from network 202 via a communication channel 218. Land-line telephone 210 is able to send/receive information to/from network 202 via a communication channel 220. Communication device 212 is able to send/receive information to/from network 202 via a communication channel 222. In accordance with aspects of the present invention, communication device 204 is additionally operable to send/receive information to/from communication device 206 via a communication channel 224.

[8832] Each and every one of communication device 204, communication device 206, computer 208, landmine telephone 210 and communication device 212 is able to communicate with one another by way of network 202.

10833] Communication channels 214, 216, 218, 220 and 222 may be any known wired or wireless communication channel. Communication channel 224 may be any known wireless communication channel.

(0034) An example implementation of an aspect in accordance with the present invention, by way of communication device 204 and communication device 206, may autonomously facilitate crash avoidance. This will now be further described with reference to FIGs. 3A-C.

[8835] FIGs. 3A-C illustrate two vehicles travelling at times $t_4$, $t_5$, and $t_6$, respectively, and ultimately avoiding a crash in accordance with aspects of the present invention.

[0036] FIG. 3A includes vehicle 102 and vehicle 104 at a time $t_3$. Vehicle 102 has communication device 204 therein, and is traveling in a direction indicated by arrow 310. Vehicle 104 has a communication device 206 therein, and is traveling in a direction indicated by arrow 312. Here, communication device 204 is in communication with communication device 206 via communication channel 224. In example embodiments, communication
device 204 and communication device 206 are exchanging information related to each other's respective location and velocity.

At time $t_4$, the driver of vehicle 102 changes direction without seeing vehicle 104. This is shown in FIG. 3B. In particular, at time $\frac{3}{4}$ vehicle 102 is traveling in the direction indicated by arrow 314. Here, again, communication device 204 is in communication with communication device 206 via communication channel 224. Again in this example, communication device 204 and communication device 206 are exchanging information related to each other's respective location and velocity. Further, communication device 206 provides an alert, as shown in the figure as item 316, to alert driver of vehicle 104 that if vehicle 102 proceeds along direction 314 is likely to collide with vehicle 104.

As shown in FIG. 3C, at time $t_5$, the driver of vehicle 104 changes direction as indicated by arrow 316 irrespective of whether the driver of vehicle 102 has seen vehicle 104. As such, the driver of vehicle 104 avoids crashing into vehicle 102.

In the example embodiments discussed above with reference to FIGs. 3A–C, communication device 204 is operable to wirelessly communicate with communication device 206. However, this is a non-limiting example for purposes of discussion. It should be noted that a plurality of communication devices may be able to communicate with one another. Further, in the example discussed above with reference to FIGs. 3A–C, communication device 206 is operable to provide a warning to the driver of vehicle 104. However, in accordance with aspects of the present invention, communication device 204 may similarly provide a warning to the driver of vehicle 102 based on information provided by communication device 206, which was explicitly not discussed for purposes of brevity.

The implementation of an aspect of the present invention discussed above with reference to FIGs. 3A–C is a non-limiting example implementation. In general, an aspect of the present invention enables communication devices to wirelessly communicate with one another wherein at least one of the communication devices then autonomously provides a function based on the wireless communication with the other communication device.

A more detailed discussion of an example communication device and method in accordance with aspects of the present invention will now be described with reference to FIGs. 4–6.
FIG. 4 illustrates an example communication device 206 in accordance with aspects of the present invention.

FIG. 4 includes a device 204, a device 206, a database 404, a field 406 and a network 408. In this example embodiment, device 206 and database 404 are distinct elements. However, in some embodiments, device 206 and database 404 may be a unitary device as indicated by dotted line 410.

Device 206 includes a field-detecting component 412, an input component 414, an accessing component 416, a comparing component 418, an identifying component 420, a parameter-detecting component 422, a communication component 424, a verification component 426 and a controlling component 428.

In this example, field-detecting component 412, input component 414, accessing component 416, comparing component 418, identifying component 420, parameter-detecting component 422, communication component 424, verification component 426 and controlling component 428 are illustrated as individual devices. However, in some embodiments, at least two of field-detecting component 412, input component 414, accessing component 416, comparing component 418, identifying component 420, parameter-detecting component 422, communication component 424, verification component 426 and controlling component 428 may be combined as a unitary device. Further, in some embodiments, at least one of field-detecting component 412, input component 414, accessing component 416, comparing component 418, identifying component 420, parameter-detecting component 422, communication component 424, verification component 426 and controlling component 428 may be implemented as a computer having tangible computer-readable media for carrying or having computer-executable instructions or data structures stored thereon. Such tangible computer-readable media can be any available media that can be accessed by a general purpose or special purpose computer. Non-limiting examples of tangible computer-readable media include physical storage and/or memory media such as RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to carry or store desired program code means in the form of computer-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer. For information transferred or provided over a network or another communications connection (either hardwired, wireless, or a combination
of hardwired or wireless) to a computer, the computer may properly view the connection as a computer-readable medium. Thus, any such connection may be properly termed a computer-readable medium. Combinations of the above should also be included within the scope of computer-readable media.

[0046] Controlling component 428 is arranged to communicate with: field-detecting component 412 via a communication channel 434; input component 414 via a communication channel 432; accessing component 416 via a communication channel 434; comparing component 418 via a communication channel 436; identifying component 420 via a communication channel 438; parameter-detecting component 422 via a communication channel 440; communication component 424 via a communication channel 442; and verification component 426 via a communication channel 444. Controlling component 428 is operable to control each of field-detecting component 412, input component 414, accessing component 416, comparing component 418, identifying component 420, parameter-detecting component 422, communication component 424 and verification component 426.

[0047] Field-detecting component 412 is additionally arranged to detect field 406, to communicate with input component 414 via a communication channel 446, to communicate with comparing component 418 via a communication channel 448 and to communicate with parameter-detecting component 422 via a communication channel 460. Field-detecting component 412 may be any known device or system that is operable to detect a field, non-limiting examples of which include an electric field, a magnetic field, and electro-magnetic-field and combinations thereof. In some non-limiting example embodiments, field-detecting component 412 may detect the amplitude of a field at an instant of time. In some non-limiting example embodiments, field-detecting component 412 may detect a field vector at an instant of time. In some non-limiting example embodiments, field-detecting component 412 may detect the amplitude of a field as a function over a period of time. In some non-limiting example embodiments, field-detecting component 412 may detect a change in the amplitude of a field as a function over a period of time. In some non-limiting example embodiments, field-detecting component 412 may detect a change in a field vector as a function over a period of time. Field-detecting component 412 may output a signal based on the detected field.
Input component 414 is additionally arranged to communicate with database 404 via a communication channel 450 and to communicate with verification component 426 via a communication channel 452. Input component 414 may be any known device or system that is operable to input data into database 404. Non-limiting examples of input component 414 include a graphic user interface (GUI) having a user interactive touch screen or keypad.

Accessing component 416 is additionally arranged to communicate with database 404 via a communication channel 454 and to communicate with comparing component 418 via a communication channel 456. Accessing component 416 may be any known device or system that can access data from database 404.

Comparing component 418 is additionally arranged to communicate with identifying component 420 via a communication channel 458. Comparing component 418 may be any known device or system that can be operable to compare two inputs.

Parameter-detecting component 422 is additionally arranged to communicate with identifying component 420 via a communication channel 460. Parameter-detecting component 422 may be any known device or system that is operable to detect a parameter, non-limiting examples of which include velocity, acceleration, angular velocity, angular acceleration, geodetic position, light, sound, temperature, vibrations, pressure, biometries, contents of surrounding atmosphere and combinations thereof. Some non-limiting example embodiments, parameter-detecting component 422 may detect the amplitude of a parameter at an instant of time. In some non-limiting example embodiments, parameter-detecting component 422 may detect a parameter vector at an instant of time. In some non-limiting example embodiments, parameter-detecting component 422 may detect the amplitude of a parameter as a function over a period of time. In some non-limiting example embodiments, parameter-detecting component 422 may detect a parameter vector as a function over a period of time. In some non-limiting example embodiments, parameter-detecting component 422 may detect a change in the amplitude of a parameter as a function over a period of time. In some non-limiting example embodiments, parameter-detecting component 422 may detect a change in a parameter vector as a function over a period of time.

Communication component 424 is additionally arranged to communicate with network 408 via communication channel 214 and to communicate with communication device 204 via communication channel 224. Communication component 424 may be any
known device or system that is operable to communicate with network 408. Non-limiting examples of communication component include a wired and a wireless transmitter/receiver.

Verification component 426 may be any known device or system that is operable to provide a request for verification. Non-limiting examples of verification component 426 include a graphic user interface having a user interactive touch screen or keypad.

Communication channels 430, 432, 434, 436, 438, 440, 442, 444, 446, 448, 450, 452, 454, 456, 458, 460 and 214 may be any known wired or wireless communication channel.

Database 404 may be any known device or system that is operable to receive, store, organize and provide (noon a request) data, wherein the "database" refers to the data itself and supporting data structures. Non-limiting examples of database 404 include a memory hard-drive and a semiconductor memory.

Network 408 may be any known linkage of two or more communication devices. Non-limiting examples of database 408 include a wide-area network, a local-area network and the Internet.

FIG. 5 illustrates an example parameter-detecting component 422.

As shown in the figure, parameter-detecting component 422 includes a plurality of detecting components, a sample of which are indicated as a first detecting component 502, a second detecting component 504, a third detecting component 506 and an nth detecting component 508. Parameter-detecting component 422 additionally includes a controlling component 510.

In this example, detecting component 502, detecting component 504, detecting component 506, detecting component 508 and controlling component 510 are illustrated as individual devices. However, in some embodiments, at least two of detecting component 502, detecting component 504, detecting component 506, detecting component 508 and controlling component 510 may be combined as a unitary device. Further, in some embodiments, at least one of detecting component 502, detecting component 504, detecting component 506, detecting component 508 and controlling component 510 may be implemented as a computer having tangible computer-readable media for carrying or having computer-executable instructions or data structures stored thereon.
Controlling component 510 is configured to communicate with; detecting component 502 via a communication channel 512; detecting component 504 via a communication channel 514; detecting component 506 via a communication channel 516; and detecting component 508 via a communication channel 518. Controlling component 510 is operable to control each of detecting component 502, detecting component 504, detecting component 506 and detecting component 508. Controlling component 510 is additionally configured to communicate with controlling component 428 of FIG. 4 via communication channel 440 and to communicate with field-detecting component 412 of FIG. 4 via communication channel 460.

The detecting components may each be a known detecting component that is able to detect a known parameter. For example each detecting component may be a known type of detector that is able to detect at least one of magnetic fields in any of three dimensions, electric fields in any of three dimensions, electric fields in any of three dimensions, electro-magnetic fields in any of three dimensions, velocity in any of three dimensions, acceleration in any of three dimensions, angular velocity in any of three dimensions, angular acceleration in any of three dimensions, geodetic position, sound, temperature, vibrations in any of three dimensions, pressure in any of three dimensions, biometrics, contents of surrounding atmosphere, a change in electric fields in any of three dimensions, a change in magnetic fields in any of three dimensions, a change in electro-magnetic fields in any of three dimensions, a change in velocity in any of three dimensions, a change in acceleration in any of three dimensions, a change in angular velocity in any of three dimensions, a change in angular acceleration in any of three dimensions, a change in geodetic position in any of three dimensions, a change in sound, a change in temperature, a change in vibrations in any of three dimensions, a change in pressure in any of three dimensions, a change in biometrics, a change in contents of surrounding atmosphere and combinations thereof. For purposes of discussion, let; detecting component 502 be able to detect deceleration in three dimensions; detecting component 504 be able to detect sound; detecting component 506 be able to detect vibrations; and detecting component 508 be able to detect geodetic position.
[0062] In some non-limiting example embodiments, at least one of the detecting components of parameter-detecting component 422 may detect a respective parameter as an amplitude at an instant of time. In some non-limiting example embodiments, at least one of the detecting components of parameter-detecting component 422 may detect a respective parameter as a function over a period of time.

[0063] Each of the detecting components of parameter-detecting component 422 is able to generate a respective detected signal based on the detected parameter. Each of these detected signals may be provided to controlling component 510 via a respective communication channel.

[0064] Controlling component 519 is able to be controlled by controlling component 428 via communication channel 440.

[0065] FIG. 6 illustrates an example method 600 of communicating between two communication devices in accordance with aspects of the present invention. For purposes of discussion, method 600 will be described with reference to the situation discussed above in FIGs. 3A-C.

[0066] As shown in the figure, method 600 starts (S602) and it is determined whether the communication mode of the communication device is active (S604). If a smartphone is not currently functioning in a communication mode that allows wireless communication with other nearby smartphones, then the remainder of method 600 may not occur (N at S604). Otherwise, method 600 continues (Y at S604). In some embodiment, a smartphone may not be currently functioning in a communication mode that allows wireless communication with other nearby smartphones as a result of the user actively disabling such functioning. In some embodiments, a smartphone may function in a communication mode that allows wireless communication with other nearby smartphones by default when the smartphone is powered.
For example, returning to FIG. 4, communication device 206 may be operable to communicate with network 202 in a first mode and may be operable to communicate with communication device 204 via communication channel 224 in a second mode. For purposes of discussion, let the first mode be a cellular communication mode wherein communication device 206 is able to communicate with network 202 such that communication channel 214 is a cellular communication channel. Further, let the second mode be a wireless communication mode, non-limiting examples of which include Wi-Fi and Bluetooth, wherein communication device 206 is able to communicate with communication device 284. In this manner, communication channel 224 might have less bandwidth restrictions and less power requirements for communication as compared with the first mode communicating over communication channel 214.

In some example embodiments, controlling component 428 is able to instruct communication portion 424, by way of communication channel 442, to operate in the first mode or the second mode. For example, a user by way of the GUI of input component 414, may enable controlling component 428 to instruct communication portion to operate in the second mode. In some example embodiments, communication device 206 may operate in the second mode of communication by default.

In any event, in some example embodiments, controlling component 428 is operable to determine whether communication component 424 is operating in the second communication mode, such that communication device 206 may wirelessly communicate with communication device 204.

Returning to FIG. 6, if it is determined that communication device 206 does not have the second communication mode active (N at S604), then it continues to check for activation of the second communication mode (S604). For example, let communication device 206 not be operating in the second communication mode. Therefore, communication device 286 would not be able to receive communication from communication device 204 via communication channel 224.

If it is determined that communication device 286 has the second communication mode active (Y at S604), it is then determined whether the communication device is in a vehicle (S606). In accordance with this aspect of the present invention, a smartphone is able to autonomously determine whether it is disposed within a vehicle. This determination
enables more efficient processing for the remainder of method 600, as will be described in more detail below, because farther determinations will be divided between in-vehicle situations ($608, 610, 612$ and $614$) and non-in-vehicle situations ($616, 618, 620$ and $622$).

[0072] For example, returning to FIG. 4, let communication device 206 be operating in the second communication mode, wherein communicates with communication device 204 via communication channel 224. At this point, communication device 206 may determine that it is in vehicle 102 by any known method. In some embodiments, communication device 206 may determine that it is in vehicle 102 by: 1) detecting a field; 2) detecting at least one other parameter; 3) generating a signature based on the detected field and the detected at least one other parameter; and 4) comparing the generated signature with previously stored signatures associated with the vehicle. Examples of embodiments where communication device 206 may determine that it is in vehicle 102 are described in greater detail as disclosed in co-pending US patent Application No. 14/072,231 filed November 5, 2013. In some embodiments, communication device 206 may determine that it is in vehicle 102 in a manner disclosed in co-pending US patent Application No. 14/095,156 filed December 3, 2013. In some embodiments, communication device 206 may determine that it is in vehicle 102 in a manner disclosed in U.S. Application No. 14/105,744 filed December 13, 2013. In some embodiments, communication device 206 may determine that it is in vehicle 102 in a manner disclosed in U.S. Application No. 14/105,934 filed December 13, 2013.

[0073] Returning to FIG. 6, if it is determined that communication device 206 is in a vehicle (Y at $606$), then it is determined whether a vehicle mode signal is received ($608$). A vehicle mode signal is a signal from a communication device indicating that it is in a vehicle and is communicating through the wireless channel to other communication devices. If the smartphone is does not receive a vehicle mode signal from another communication device, then the remainder of method 600 may not occur (N at $608$). Otherwise, method 600 continues (Y at $608$). In some embodiment, although a smartphone may enabled and ready to communicate with other communication devices there may be situations where there are no communication devices nearby that are ready or able to provide vehicle mode signals. In such situations, the smartphone would essentially wait to receive vehicle mode signals.
For example, returning to FIG. 3A, for purposes of discussion, let communication device 204 be able to operate in a second communication mode, wherein communication device 204 may transmit a signal along communication channel 224 to communication device 206. To simplify the discussion, let the second communication mode be a vehicle mode, indicating that communication device 204 is in a vehicle.

If it is determined that a vehicle mode signal is not received (N at $S608$), then it continues to check for activation of the second communication mode ($S604$). For example, returning to FIG. 4, in the event that communication device 204 is not transmitting a signal indicating that it is operating in a vehicle mode or communication device 206 is out of range of receiving such a communication, then communication component 424 will not receive such a signal. This situation may occur when no other communication devices are within range of a receiving communication device.

Returning to FIG. 6, if it is determined that a vehicle mode signal is received (Y at $S605$), then it is determined whether a subsequent notice signal is received ($S610$). A subsequent notice signal is a signal received after the vehicle mode signal and that provides further information related to the communication device providing the subsequent notice signal. If the smartphone does not receive a subsequent notice signal from another communication device, then the remainder of method 600 may not occur (N at S610). Otherwise, method 600 continues (Y at 8610). In some embodiment, although a smartphone may enabled and ready to communicate with other communication devices, and may have received vehicle mode signals from at least one other nearby communication device, there may be situations where there are no communication devices nearby that are ready or able to provide vehicle subsequent notice signals. In such situations, the smartphone would essentially wait to receive subsequent notice signals.

For example, returning to FIG. 4, in the event that communication device 204 is transmitting a signal indicating that it is operating in a vehicle mode and communication device 206 is within range of receiving such a communication, then communication component 424 may receive the signal from communication device 206.
Returning to FIG. 3A, in an example implementation, communication device 204 transmits a vehicle mode signal by way of communication channel 224 to communication device 206. In this manner, communication device 206 is aware that communication device 204 is in a vehicle mode and communication device 206 awaits a subsequent signal from communication device 204.

A subsequent signal from communication device 204 may be a notice-signal having information therein. Non-limiting examples of types of information in the notice signal include: geodetic location of the vehicle in which the communication device that is sending the notice signal is disposed; velocity of the vehicle in which the communication device that is sending the notice signal is disposed; acceleration of the vehicle in which the communication device that is sending the notice signal is disposed; a change in geodetic location of the vehicle in which the communication device that is sending the notice signal is disposed; a change in velocity of the vehicle in which the communication device that is sending the notice signal is disposed; a change in acceleration of the vehicle in which the communication device that is sending the notice signal is disposed; identification, e.g., make, model, year, of the vehicle in which the communication device that is sending the notice signal is disposed; relay of information from another vehicle in which another communication device that is sending the original notice signal is disposed; destination information of the vehicle in which the communication device that is sending the notice signal is disposed; social networking information of the owner of the communication device within the vehicle in which the communication device that is sending the notice signal is disposed; and combinations thereof.

Returning to FIG. 6, if it is determined that a subsequent notice signal is not received (N at $610$), then it continues to check for activation of the second communication mode ($604$). For example, returning to FIG. 4, in the event that communication device 204 does not transmit a subsequent notice signal or communication device 206 is out of range of receiving such a signal, then communication component 424 will not receive such a signal.

Returning to FIG. 6, if a subsequent notice signal is received (¼ at $610$), then it is determined—whether a function is required ($612$). At this point in method 600, a smartphone will have autonomously received information from a nearby smartphone wherein the information relates to aspects of the nearby smartphone. In some situations the information
relating to expects of the nearby smartphone ray affect or be important to its user (and by extension the vehicle of the user in which the smartphone is currently disposed). Therefore the smartphone may be able to autonomously perform a function based on the received information that relates to aspects of the nearby smartphone. If the smartphone does not need to perform a function based on the received information from the nearby smartphone, then the remainder of method 600 may not occur (N at S612). Otherwise, the function is performed (Y at S612).

[0082] For example, returning to FIG. 4, in the event that communication device 204 is transmitting a notice signal and communication device 206 is within range of receiving such a signal then communication component 424 may receive the notice signal. Controlling component 428 may then determine whether a function is required.

[0083] In some example embodiments, database 404 may store associations between information of notice signals and functions. Non-limiting examples of functions include providing an audible, tactile (vibrating) and/or a visual warning. For example, formation of a notice signal indicating a collision course based on any one of position, velocity and acceleration of a vehicle with which a communication device disposed may be associated with a function prompting a warning alert. The warning alert may be any one of a tactile alert, audible alert, visual alert and combinations thereof that may be generated by the communication device receiving the notice signal.

[0084] In some example embodiments, controlling component 428 may access database 404 by way of access component 416. Controlling component 428 may therefore determine whether information of a notice signal has an associated function that should be performed.

[0085] Returning to FIG. 6, if a function is not to be performed (N at §612), then device 204 continues to check for activation of the second communication mode (S604). For example, returning to FIG. 4, in the event that controlling component 428 determines that information of a receive notice signal has no associated function that should be performed, then no function is performed.

[0086] Returning to FIG. 6, if it is determined that a function is to be performed (Y at S612), then the function is performed (S614). For example, returning to FIG. 3B, consider that communication device 204 transmits a notice having information related to its current
beat ion and velocity associated with arrow 314. In this case, communication device 206 may determine that a collision is imminent. As shown in FIG. 4, controlling component 428 may determine, through an association stored in database 404, that the information related to the current location and direction of vehicle 102 (in which communication device 206 is disposed) corresponds to an imminent collision and therefore initiates a predetermined action to generate an alert.

Returning to FIG. 3B, communication device 206 provides an alert as shown by item 316. In an example embodiment, the alert includes an audible tactile and visual alert to warn the driver of vehicle 104. As a result, as shown in FIG. 3C, driver of vehicle 104 is able to change direction (or speed) as shown by arrow 316 thus avoiding a collision with vehicle 102.

Returning to FIG. 6, method 600 then continues to check for activation of the second communication mode (S604).

If communication device 206 is not in a vehicle (N at S606), then it is determine whether a mode signal is received (S616), whether a subsequent notice is received (S618), whether a function is to be performed (S620), and if so, then the function is performed (S622). These portions of method 600 are similar to the previously discussed portions of method 600 (S608, S610, S612 and S614, respectively). The difference being that, in this portion of method 600 (S616, S618, S620 and S622) communication device 206 is not in a vehicle.

For example, if the communication device is not in a vehicle (N at S616), and a mode signal is received (Y at S616) then the communication device will be aware of nearby communication devices that are able to wireless communicate. This may occur for example if the person earning the communication device is walking.

Further, if a subsequent notice signal is received (Y at S618), then the communication device will be aware of at least one nearby communication device that is providing additional information. As such, returning to FIG. 4, any associations with which controlling component 428 accesses in database 404 are limited to those that do not deal with communication device 204 being in a vehicle.
For example, along this portion of method 608 (S616, S618, S620, S622), and applicable situation may deal with a user walking with communication device 206. For example, consider the situation where the user of communication device 204 is within a social network of the user of communication device 206. Further, let the user of negation device 206 he near the user carrying communication device 204. In accordance with this aspect of the present invention, communication device 206 may determine an association between the proximity of communication device 204 and providing an alert. As such, communication device 206 may ultimately perform a function (S622) alerting the user of communication device 206 that the user, who is within the social network of the user of communication device 206, is proximate to the location of the user of communication device 204.

In the example embodiment discussed above with reference to FIG. 6, communication device 206 is able to perform a function based on received signals from communication device 204. As mentioned previously, a similar method may be performed by communication device 204 based on received signals from communication device 204. Farther, in the example embodiment discussed above with reference to FIG. 6, communication device 206 is able to perform a function based on received signals from a single communication device, it should be noted that in accordance with aspects of the present invention, communication device 206 may be able to perform a function on received signals from any one of a plurality of communication devices.

The example embodiments discussed above are drawn to enabling a wireless communication device two wireless communication device communication mode. Once this mode, the example embodiments discussed above are additionally drawn to determining, via a communication device, whether the communication device is within a vehicle using fields and other parameters associated with the vehicle. The example embodiments discussed above are additionally drawn to enabling a communication device to receive; 1) communication mode signals from nearby wireless communication devices; and 2) a subsequent notice from these nearby wireless communication devices. Finally, the examples discussed above are additionally drawn to enabling a communication device to autonomously perform various functions based on the subsequent notices.
In essence, aspects of the present invention enable a smartphone to autonomously and wirelessly communicate with nearby smartphones and to autonomously perform functions based on these wireless communications.

In accordance with aspects of the present invention discussed above, the sensors and functionalities of smartphones can be used to supplement or even replace the known vehicle-based techniques of vehicle telematics. More specifically, smartphone-to-smartphone (when both phones are in Vehicle Mode), smartphone-to-infrastructure and infrastructure-to-smartphone communications (again, when the smartphone is in Vehicle Mode) can provide drivers with a wide range of telematics services and features, while resulting in little or no additional cost to the vehicle driver (depending on her smartphone contract) or the vehicle manufacturer (because it does not have to provide the purchaser of the vehicle with a smartphone and also doesn't have to embed costly vehicle telematics equipment in the vehicle). To be able to do so, however, the smartphone again has to be able to "know" that it is in Vehicle Mode and be able to determine in what vehicle it is. For various applications, it may be necessary to determine if the smartphone is in the vehicle that is owned by the smartphone user. Aspects of the present invention enable a smartphone to know that it is in Vehicle Mode based on detected magnetic, electric, magneto-electric fields and combinations thereof.

Further in accordance with the present invention, a smartphone may utilize its magnetometer function to periodically measure the electromagnetic levels sensed at the smartphone's current location. The smartphone uses its processing capabilities to try to map the periodic electromagnetic levels sensed by the smartphone with the vehicular electro-magnetic signatures stored in library. If the periodic electromagnetic levels sensed by the smartphone match any of the specific vehicle signatures stored in the library, then the processor of the smartphone may generate and/or otherwise output a signal indicating that the smartphone is located in the specific vehicle, which in turn will be used by the Vehicle Mode detection method to trigger certain functions.
The Vehicle Mode relevant sensor suite may be monitored at intervals depending on detected speed and location, for example, up to several times per second. The magneto metric sensor output may be monitored dependent on the accelerometer output as this will indicate a movement of the phone either within the vehicle environment or of the vehicle itself.

In accordance with another aspect of the present invention, collisions between pedestrians and vehicles may be reduced. For example, when a pedestrian walks into the pathway of a vehicle, the smartphone of the pedestrian will provide a warning to the pedestrian of the oncoming vehicle. Further, the smartphone of the driver of the oncoming vehicle will provide a warning to the driver of the vehicle.

As shown in FIG. 7A a person 702, at a time t₁, is carrying a smartphone 704 in accordance with aspects of the present invention. Person 702 is walking with a velocity, indicated by arrow 706, adjacent to a road 708. On road 708 are a plurality of vehicles, including vehicle 710 having a smartphone 712 therein. Vehicle 710 is driving with a velocity, indicated by arrow 714, adjacent to a road 708.

As shown in FIG. 7B person 702, at a time t₂, is walking with a velocity, indicated by arrow 714, into road 708 and into the path of vehicle 710. In such a situation, a collision might happen between person 702 and vehicle 710. However, in accordance with aspects of the present invention, smartphone 704 would warn user 702 of oncoming vehicle 710 and smartphone 712 would warn the driver of vehicle 710 of user 702. Such warnings may help to avoid such a collision.

The geodetic location of a smartphone is detected automatically by the smartphone. Further, the velocity of the smartphone is automatically detected by the smartphone. This location and velocity data is uploaded to a server. This will be described in greater detail with reference to FIG. 8.

FIG. 8 illustrates a communication system 800 in accordance with aspects of the present invention.

Communication system 800 is similar to communication system 200 discussed above with reference to FIG. 2. Communication system 800 however further includes a server 802 in communication with network 200 via a communication channel 804.
In this example embodiment, server 802 is operable to provide a likelihood of collision between two smartphone users based on parameters associated with the smartphones. For example, the position and velocity of each smartphone may be used to determine a likelihood of collision between the two smartphones. Further, other criteria, non-limiting examples of which include the time of year, time of week, time of day and whether may be used to more accurately determine a likelihood of collision between the two smartphones. Still further, thresholds of criteria may be set to filter unlikely collisions between the two smartphones, thereby reducing processing resources.

The operation of system 800 will be described in greater detail with reference to FIGS. 9-11B.

FIG. 9 illustrates an example method 900 of avoiding a collision between people by communicating between two communication devices in accordance with aspects of the present invention.

As shown in the figure, method 900 starts (S902) and criteria are set (S904). For example, as shown in FIG. 4, controlling component 428 may set criteria. This will be described with additional reference to FIG. 10.

FIG. 10 illustrates an exploded view of an example embodiment of controlling component 428 in accordance with aspects of the present invention.

As shown in the figure, controlling component 428 includes a criteria setting component 1002, a position determining component 1004, a threshold setting component 1006, a vector determining component 1010, a velocity determining component 1008, a vector information receiving component 1012, a collision determining component 1014 and a signal component 1016.
In this example, criteria selling component 1002, position determining component 1004, threshold setting component 1006, vector determining component 1008, vector information receiving component 1012, collision determining component 1014 and signal component 1016 are illustrated as individual devices. However, in some embodiments, at least two of criteria setting component 1002, position determining component 1004, threshold setting component 1006, vector determining component 1010, velocity determining component 1008, vector information receiving component 1012, collision determining component 1014 and signal component 1016 may be combined as a unitary device. Further, in some embodiments, at least one of criteria setting component 1002, position determining component 1004, threshold setting component 1006, vector determining component 1010, velocity determining component 1008, vector information receiving component 1012, collision determining component 1014 and signal component 1016 may be implemented as a computer having tangible computer-readable media for carrying or having computer-executable instructions or data structures stored thereon.

Criteria setting component 1002 is arranged to communicate with input component 414 via communication channel 432 and to communicate with threshold setting component 1006 via a communication channel 1018. Criteria setting component 1002 may be any system or device that is able to establish a criterion or criteria to filter unlikely collisions. Non-limiting examples of criteria to filter unlikely collisions include day of year, day of week, time of day, geographic location, temperature, precipitation, ambient brightness and combinations thereof.

For example, a December 25th, Christmas day, might historically provide less pedestrian and vehicular traffic in a town area as compared to a January 1st, New Year’s Day. As such, the day of the year may be a criterion to filter unlikely collisions.

As another example, a Saturday might historically provide more pedestrian and vehicular traffic in a town area as compared to a Sunday. As such, the day of the week may be a criterion to filter unlikely collisions.

As another example, the time between 4:00 and 5:00 pm might historically provide more pedestrian and vehicular traffic in a town area as compared to the time between 1:00 and 3:00 pm. As such, the time of day may be a criterion to filter unlikely collisions.
[00116] As another example, one specific part of town might historically provide more pedestrian and vehicular traffic as compared to another part of town. As such, the geographic location may be a criterion to filter unlikely collisions.

[00117] As another example, if the outside temperature is below 32° F, there is an increased likelihood of ice on the streets, which will required more advanced warning for a driver of a vehicle to safely stop to avoid a collision. As such, the temperature may be a criterion to filter unlikely collisions.

[00118] As another example, if it is mining, there is an increased likelihood of the streets being slippery, which will required more advanced warning for a driver of a vehicle to safely stop to avoid a collision. As such, the precipitation may be a criterion to filter unlikely collisions.

[00119] As another example, if the area is not well-lit, a driver of a vehicle may have less warning for to safely stop to avoid a collision. As such, the ambient brightness may be a criterion to filter unlikely collisions.

[00120] In some embodiments, criteria setting component 1002 is operable to set criteria via any instructions by input component 414 through communication channel 432. For example, a user may set criteria through a GUI. In some embodiments, criteria setting component 1002 may have criteria pre-installed when communication device 206 is manufactured.

[00121] Before moving on to the further description of method 900, the remainder of the components of controller 428 in FIG. 10 will be briefly introduced.

[00122] Position determining component 1004 is arranged to communicate with communication component 424 via communication channel 442, to communicate with vector determining component 1010 via a communication channel 1020, to communicate with velocity determining component 1008 via a communication channel 1022 and to communicate with parameter detector 422 via communication channel 440. Position determining component 1004 may be any system or device that is able to determine the position of communication device 206.
[0023] In some embodiments, position determining component 1004 is operable to determine a position of co-ramtmiacain device 206 by detected parameters, whereto parameter detector 422 provides information via communication channel 446. For example, in some embodiments, parameter detector 422 may include a GPS receiver that provides a position signal. In some embodiments, parameter detector 422 may include WiFi hotspot detectors that are able to provide a position signal. In some embodiments, position determining component 1004 is operable to determine a position of communication device 206 by receiving a position signal through communication component 424 through communication channel 442. For example, communication component 424 may receive a position signal through an external GPS system via communication channel 214.

[0024] Threshold setting component 1006 is additionally arranged to communicate with input component 414 via communication channel 432 and to communicate with collision determining component 1014 via a communication channel 1024. Threshold setting component 1006 may for any device or system that is able to establish a threshold associated with the criteria in criteria setting component 1882.

[0025] In some embodiments, threshold setting component 1006 is operable to set criteria via an instruction by input component 414 through communication channel 432. For example, a user may set thresholds for each criterion through a GUI, in some embodiments, criteria setting component 1002 may have thresholds for each criterion pre-installed when communication device 206 is manufactured.

[0026] Velocity determining component 1008 is additionally arranged to communicate with communication component 424 via communication channel 442, to communicate with vector determining component 1010 via a communication channel 1026 and to communicate with parameter detector 422 via communication channel 440. Velocity determining component 1008 may be any system or device that is able to determine the position of communication device 206.

[0027] In some embodiments, velocity determining component 1008 is operable to determine a velocity of communication device 206 by detected parameters, wherein parameter detector 422 provides information via communication channel 442. For example, in some embodiments, parameter detector 422 may include a velocity determining component 1008 for two times, such that a velocity may be determined. In some embodiments, velocity determining component 1008 is operable to determine a velocity of communication device 206 by detected parameters, wherein parameter detector 422 provides information via communication channel 442.
component 1008 is operable to determine a velocity of communication device 206 by receiving a velocity signal through communication component 424 through communication channel 442. For example, communication component 424 may receive a velocity signal from an external GPS system via communication channel 214.

[00128] Vector determining component 1010 is additionally arranged to communicate with collision determining component 1014 via a communication channel 1028. Vector determining component 1010 may be any device or system that is able to determine a vector of communication device 206 based on the position and velocity of communication device 206.

[00129] In an example embodiment, vector determining component 1010 determines a vector of communication device 206 from the position of communication device 206 as provided by position determining component 1004 via communication channel 1020 and from the velocity of communication device 206 as provided by velocity determining component 1008 via communication channel 1026.

[00130] Vector information receiving component 1012 is arranged to communicate with communication component 424 via communication channel 442 and to communicate with collision determining component 1014 via a communication channel 1030. Vector information receiving component 1012 may be any system or device that is able to receive vector information associated with another communication device. For example, communication component 424 may receive vector information describing the location and velocity of nearby communication devices. As shown in FIG. 4, this information may be provided directly from the devices themselves, e.g. communication device 224, or through network 202.

[00131] Collision determining component 1014 is additionally arranged to communicate with communication component 424 via communication channel 442, to communicate with input component 414 via communication channel 432 and to communicate with signal component 1016 via a communication channel 1032. Collision determining component 1014 may be any system or device that is able to determine a likelihood of collision between a person having communication device 206 thereon (or vehicle having communication device 206 therein) and another communication device based on the received vector information of
the other communication device, the determined position of communication device 296 and the
determined velocity of communication device 206.

[00132] Collision determining component 1014 determines if thresholds are met of set
criteria and if the vector of communication device 206 in relation to the received vector of
another communication device will likely result in a collision.

[00133] Signal component 1016 may be any system or device that is able to provide a
signal associated with the likelihood of collision. In some embodiments, the signal is a
warning signal. Non-limiting examples of types of warning signals includes audible, visual,
tactile and combinations thereof. In some embodiments, the signal is an activation signal to
activate a function in communication device 206. In some embodiments, the signal is an
activation signal to be transmitted to another device to activate a function in such other
device.

[00134] Returning to FIG. 9, after the criteria are set (S904), thresholds are set (S906). For
example, as shown in FIG. 10, threshold setting component 1006 sets thresholds for criteria
provided by criteria setting component 1002. The set thresholds adjust the warning area for
determining the likelihood of a collision. This will be described with additional reference to
FIGs. 11A-11B.

[00135] As shown in FIG. 11A, a person 1102, a person 1104, a person 1106 and a person
1108 are walking near an intersection 1100. A vehicle 1118 is driving towards intersection
1100. Each of persons 1102, 1104, 1106 and 1108 has a respective smartphone (not shown)
registered with server 802 of FIG. 8, that is able to provide its respective location and
velocity data to server 802. Similarly, the smartphone (not shown) of the driver of vehicle
1118 is additionally registered with server 802 and is able to provide its respective location
and velocity data to server 802.

[00136] Each smartphone has a warning area associated therewith. In some embodiments
a smartphone detemines the area of activation. In some embodiments, server 802 determines
the area of activation.
In some embodiments, the size of the area of activation is determined by a threshold setting component such as threshold setting component 1006 of FIG. 1.0. More specifically, in such embodiments, the size of the area of activation is imposed on the thresholds set by threshold setting component of the criteria set by criteria setting component 1002. For example, the warning area may be based on the velocity of the smartphone. In another example, the size of the area of activation is based on the magnitude of the velocity of the smartphone. In other examples, the size of the area of activation is based on other detectable parameters, non-limiting examples of which include weather conditions, time of day, age of user, speed of the vehicle, traffic and combinations thereof. In some embodiments, the shape of the area of activation is based on other detectable parameters, non-limiting examples of which include weather conditions, time of day, age of user, speed of the vehicle, traffic and combinations thereof.

For example, in one embodiment, threshold setting component 1006 may establish a time of day threshold, t_{day}, associated with the time of day criterion such that t_{so} < t_{day} < t_{sr}, wherein t_{so} is the time of the most recent sunset of the geographic location associated with the position, and wherein t_{sr} is the time of sunrise, after t_{sr}, of the geographic location associated with the position. In another words, in this example, threshold setting component 1006 sets a threshold to determine when it is nighttime. By determining when it is nighttime, a warning area may be adjusted so as to provide a driver of a vehicle with more time to react to an imminent collision.

In another embodiment, for example, criteria setting component 1006 may establish a second criterion to filter unlikely collisions as temperature of the geographic location associated with the position. In such a case, criteria setting component 1006 may establish a temperature threshold, t_{temp}, associated with the temperature criterion such that t_{temp} < 32°F. By determining when it is below freezing, a warning area may be adjusted so as to provide a driver of a vehicle with more time to react to an imminent collision because the streets may be covered in ice.

If an area of activation of one smartphone intersects with an area of activation of another smartphone, then a determination of impending collision may be made. Excluding mutually exclusive areas of activation reduces processing resources for unlikely collisions.
For example, as shown in FIG. 11A, at a time $t_1$, persons 11.02, 11.04, 1106 and 1108 have areas of activation 1110, 11.1.2, 1114 and 1116, respectively, whereas vehicle 1.1.1.8 has area of activation 1120. In this example, vehicle 1118 is driving faster than persons 1102, 1104, 1106 and 1108 are walking. For purposes of discussion, presume that each of persons 1102, 1104, 1106 and 1108 and the person driving vehicle 1118 have similar reaction times. Since, vehicle 1118 is moving much faster than persons 1102, 1104, 1106 and 1108, for a given reaction time, vehicle 1118 will travel a much greater distance than persons 1.102, 1104, 1106 and 1108. To account for this greater distance, area of activation 1120 is much larger than any of areas of activation 1110, 1112, 1114 and 1116.

Therefore, for purposes of discussion, in this example, a threshold setting component in the smartphone (not shown) of vehicle 1.1.1.8 will have set a threshold associated with velocity of vehicle 1118 to account for the needed reaction time of the driver to stop to prevent a collision.

It is clear that areas of activation 1110, 1112 and 1114 from persons 1102, 1104 and 1.106, respectively, intersect with area of activation 1120 of vehicle 1118. As such, server 802 will determine whether the smartphone in vehicle 1118 is likely to collide with any of the smartphones carried by persons 1102, 1104 or 1106.

Returning to FIG. 9, after the thresholds are set (S906), vector information is generated (S908). For example, as shown in FIG. 10, position determining component 1004 determines a position of communication device 206 at a first time $t_0$.

In some embodiments, position determining component 1004 provides position information of the position of communication device 206 at time $t_0$ to vector determining component 1010 via communication channel 1020. Further, velocity determining component 1008 provides velocity information of communication device 206 at time $t_0$. Vector determining component 1010 generates the vector of communication device 206 at time $t_0$. 
In other embodiments, position determining component 1864 provides position information of the position of communication device 206 at time \( t \) to velocity determining component 1008 via communication channel 1822. Position determining component 1004 then provides position information of the position of communication device 206 at a future time \( t_i \) to velocity determining component 1008 via communication channel 1022. With the two positions and two times, velocity determining component 1008 determines the average velocity of communication device 206. Velocity determining component 1008 then provides the position information and the determined velocity information of communication device 206 at time \( t_i \) to vector determining component 1010 via communication channel 1026. With the position and velocity of communication device 206, vector determining component 1010 generates the vector of communication device 206 at time \( t_i \).

Returning to FIG. 9, after the vector information is generated (S968), vector information from other devices is received (S910). For example, as shown in FIG. 10, vector information receiving component 1012 receives vector information related to other communication devices via communication channel 442.

For example, as shown in FIG. 11A, let the smartphone in vehicle 1118 correspond to communication device 206 of FIG. 4. With respect to receiving vector information, as with additional reference to FIG. 11A, communication device 206 may receive vector information from the smartphones of persons 1102, 1104, 1106, and 1108. As shown in FIG. 4, this vector information may be provided via network 202 or directly to communication component 424 via communication channel 224.

Returning to FIG. 9, after vector information from other devices is received (S910), it is determined whether a collision is immanent (S912). For example, as shown in FIG. 10, collision determining component 1014 determines whether a collision is immanent.

As shown in FIG. 11B, at a time \( t_2 \), areas of activation 1110, 1112, 1114 and 1116 from persons 1102, 1104, 1106 and 1108, respectively, intersect with area of activation 1120 of vehicle 1118. As such, collision determining component 1014 will determine whether the smartphone in vehicle 1118 is likely to collide with any of the smartphones carried by persons 1102, 1104 or 1106. In this case, there is an increased likelihood that vehicle 1118 might collide with persons 1102 and/or 1108,
Returning to FIG. 9, if a collision is not immanent (No at S912), it is then determined whether the communication device is off (S914). If it is determined that the communication device is off (Yes at S914), then method 900 stops (S916).

Alternatively, if it is determined that the communication device is still on (No at S914), then vector information is again generated (return to S908).

If a collision is immanent (Yes at S912), then a signal is provided (S918). For example, as shown in FIG. 10, consider the situation where collision determining component 101.4 determines that a collision is immanent. This will he described with additional reference to FIG. 11B.

As shown in FIG. 11B, at a time ¾ areas of activation 111.0, 111.2, 111.4 and 111.6 from persons 110.2, 110.4, 110.6 and 110.8, respectively, intersect with area of activation 112.0 of vehicle 111.8. For purposes of discussion, returning to FIG. 10, suppose that vector information receiving component 101.2 provides vector information to collision determining component 101.4 associated with the vectors of smartphones of persons 110.2, 110.4, 110.6, and 110.8. Further, in this example, collision determining component 101.4 can determine that the vector of communication device 206 in vehicle 111.8 will likely intersect with the vectors of the smartphones of persons 110.2 and 110.8. In other words, vehicle 111.8 will likely collide with persons 110.2 and 110.8.

As such, as shown in FIG. 10, collision determining component 101.4 may instruct signal component 10.16 to provide a warning signal of the impending collision. In some embodiments, signal component 10.16 provides a warning signal to the user of communication device 206. In some embodiments, signal component 101.6 provides a warning signal to communication component 424, where in the warning signal is relayed to communication devices within the area of activation of communication component 424. In some embodiments, signal component 101.6 provides a warning signal to communication component 424, wherein the warning signal is relayed to server 802 so that server 802 may provide a warning to other communication devices.
Further, in some embodiments, signal component 1016 provides an activation signal to communication component 424, wherein the activation signal is relayed to traffic management systems so as to adjust traffic flow. For example, communication component 424 may provide the activation signal to traffic regulation devices, e.g., a traffic light, to regulate traffic. As such, pre-programmed traffic regulation devices may operate, not just in accordance with pre-programmed timings, but further in accordance with receipt of activation signals that provide an advanced warning of an impending collision in order to reduce the risk of collisions.

Returning to FIG. 9, after the signal is provided (S918), method 900 stops (S916).

In the example method 900 discussed above, communication device 206 within vehicle 1118 determines a likelihood of collision and provides a warning. It should be noted that the smartphones of persons 1102, 1104, 1106 and 1108 may additionally provide similar warnings.

In other embodiments, the collision determination and warning may be performed via an offsite server. For example, returning to FIG. 8, in some embodiments, each communication device may provide position and vector information to server 802. Server 802 may then make collision determinations in a manner similar to collision determining component 1014. Server 802 may then transmit warning signals to corresponding communication devices as appropriate.

For example, as shown in FIG. 11B, at a time t, areas of activation 1110, 1112, 1114 and 1116 from persons 1102, 1104, 1106 and 1108, respectively, intersect with area of activation 1120 of vehicle 1118. As such, server 802 will determine whether the smartphone in vehicle 1118 is likely to collide with any of the smartphones carried by persons 1102, 1104 or 1106. In this case, there is an increased likelihood that vehicle 1118 might collide with persons 1102 and/or 1108. As such, server 802 may instruct the smartphones of persons 1102, 1108 and the driver of vehicle 1118 of the impending collision.

When the smartphones of persons 1102, 1108 and the driver of vehicle 1118 receive the instructions from server 802, in each smartphone may provide a warning to each respective user.
In some embodiments, a change in location of one smartphone may provide a warning to another smartphone. For example, as shown in FIGs. 11A-B, person 1102 changes location while in an area of activation 1102 such that person 1102 is in the oncoming path of vehicle 1118. Such a location greatly increases the likelihood of a collision. Thus the smartphone of person 1X02 and the smartphone of driver 1118 may be warned.

In some embodiments, a change in direction or change in velocity of one smartphone may provide a warning to another smartphone. For example, as shown in FIGs. 12A-B, person 1108 changes direction while in an area of activation 1102. Such a change in direction into the oncoming path of vehicle 1118 greatly increases the likelihood of a collision. Thus the smartphone of person 1108 and the smartphone of driver 1118 may be warned.

In some embodiments, the relative position and/or velocity of two smartphones is used to determine a likelihood of a collision. Such a determined likelihood will prompt a warning by server 802.

In the example embodiments discussed above, the communication devices communicate with one another either directly or via a network. It should be noted that the network of indirect communication may include a dedicated short range communications network (DSRC). This will be described with reference to FIG. 12.

FIG. 12 illustrates an intersection 1200, which is similar to intersection 1.1.00 of FIG. 11A, but further includes DSRC nodes as DSRC light post 1202 and DSRC traffic light 1204.

In this embodiment, DSRC light post 1202 and DSRC traffic light 1204 provide a local wireless network having an area 1206. Any of the communication devices within area 1206 may communicate with one another via DSRC light post 1202 or DSRC traffic light 1204. Although the method of device communication may be adjusted to fit the DSRC nodes, the operation of the novel aspects of the present invention remain the same.

In the examples discussed above with reference to FIGs. 7A-12, the smartphones are used by walking pedestrians and vehicle drivers. It should be noted that these are non-limiting examples. In accordance with aspects of the present invention, any person using a
smartphone, wherein the person is moving in any way, may implement a warning system, e.g., a person riding a bicycle.

[00169] Further, in some embodiments, activation signals provided by communication devices are used to continuously modify traffic flow by informing one another through DSRC nodes. The constant sharing of such activation signals between communication devices through DSRC nodes provide an advanced warning of an impending collision in order to reduce the risk of collisions.

[00170] Further, in some embodiments, an autonomous vehicle or autonomous device may additionally employ aspects of the present invention. In this manner, each communication device used by a person may be a probe within a network of communication devices and autonomous vehicles/devices. In such a transportation infrastructure, each communication device used by a person is an interface between the human person and the machine ecosystem. Therefore, autonomous vehicles may probe and know the position and vectors of all humans, thus avoiding collisions between autonomous vehicles and people.

[00171] In the drawings and specification, there have been disclosed embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.
CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A smartphone comprising;
   a criteria setting component operable to establish a criterion to filter unlikely collisions;
   a threshold setting component operable to establish a threshold associated with the criterion;
   a vector determining component operable to determine a velocity and a position of said smartphone;
   a vector information receiving component operable to receive information on a velocity and a position of a second smartphone;
   a collision determining component operable to determine a likelihood of collision between said smartphone and the second smartphone based on the established threshold, the determined velocity and position of said smartphone, and the received information on the velocity and position of the second smartphone; and
   a signal component operable to provide a signal associated with the likelihood of collision,

2. A device comprising:
   a criteria setting component operable to establish a criterion to filter unlikely collisions;
   a threshold setting component operable to establish a threshold associated with the criterion;
   a position determining component operable to determine a position of said device at a first time;
   a velocity determining component operable to determine a velocity of said device at the first time;
   a vector information receiving component operable to receive vector information associated with a communication device;
   a collision determining component operable to determine a likelihood of collision between said device and the communication device based on the determined threshold, the received vector information, the determined position and the determined velocity; and
a signal component operable to provide a signal associated with the likelihood of collision.

3. The device of claim 2, further comprising a transmitting component operable to transmit device vector information based on the determined position and the determined velocity.

4. A device of claim 2, wherein said criteria setting component is operable to establish the criterion to filter unlikely collisions as one of the group consisting of day of year, day of week, time of day, geographic location, temperature, precipitation, ambient brightness and combinations thereof.

5. A device of claim 4, wherein said criteria setting component is operable to establish the criterion to filter unlikely collisions as the time of day, wherein said threshold setting component is operable to establish a time of day threshold, $t_{\text{ts}}$, associated with the time of day criterion such that $t_{\text{ts}} < t_{\text{ts}} < 4^\circ$, wherein $t_{\text{ts}}$ is the time of the most recent sunset of the geographic location associated with the position, and wherein $t_{\text{rs}}$ is the time of sunrise, after $t_{\text{rs}}$ of the geographic location associated with the position.

6. A device of claim 5, wherein said criteria setting component is operable to establish a second criterion to filter unlikely collisions as temperature of the geographic location associated with the position, and wherein said threshold setting component is further operable to establish a temperature threshold, $t_{\text{temp}}$, associated with the temperature criterion such that $t_{\text{temp}} < 32^\circ F$.

7. A device of claim 4, wherein said criteria setting component is operable to establish the criterion to filter unlikely collisions as temperature of the geographic location associated with the position, and
wherein said threshold setting component is operable to establish a temperature threshold, $T_{th\text{ temp}}$, associated with the temperature criterion such that $T_{th\text{ temp}} < 32° F$.

9. A method of detecting a likelihood of collision of a device, said method comprising: establishing, via a criteria setting component, a criterion to filter unlikely collisions; establishing, via a threshold setting component, a threshold associated with the criterion; determining, via a position determining component, a position of the device at a first time;

determining, via a velocity determining component, a velocity of the device at the first time;

receiving, via a vector information receiving component, vector information associated with a communication device;

determining, via a collision determining component a likelihood of collision between the device and the communication device based on the established threshold, the received vector information, the determined position and the determined velocity; and

providing, via a signal component, a signal associated with the likelihood of collision.

10. A method of claim 9, further comprising transmitting, via a transmitting component, device vector information based on the determined position and the determined velocity.

11. A method of claim 10,

wherein said establishing the criterion to filter unlikely collisions as comprises establishing file criterion to filter unlikely collisions as the time of day,

wherein said establishing, via a threshold setting component, a threshold associated with the criterion comprises establishing a time of day threshold, $t_{\text{th temp}}$, associated with the time of day criterion such that $t_{\text{th}} < t_{\text{th temp}} < t_{\text{th max}}$. 
wherein \( t_{ss} \) is the time of the most recent sunset of the geographic location associated with the position, and

wherein \( t_{sr} \) is the time of sunrise, after \( t_{ss} \) of the geographic location associated with the position.

12. A method of claim 11, further comprising:

establishing, via the criteria setting component, a second criterion to filter unlikely collisions as temperature of the geographic location associated with the position; and

establishing, via the threshold setting component, a temperature threshold, \( t_{th\text{temp}} \), associated with the temperature criterion such that \( t_{th\text{temp}} < 32^\circ F \).

13. A method of claim 10,

wherein said establishing the criterion to filter unlikely collisions as comprises establishing the criterion to filter unlikely collisions temperature of the geographic location associated with the position, and

wherein said establishing, via the threshold setting component; a threshold associated with the criterion comprises establishing a temperature threshold, \( t_{th\text{temp}} \), associated with the temperature criterion such that \( t_{th\text{temp}} < 32^\circ F \).

14. A non-transitory, tangible, computer-readable media having computer-readable instructions stored thereon, for use with device and \( \delta \tau \) detecting a likelihood of collision of the device, the computer-readable instructions being capable of being read by a computer and being capable of instructing the computer to perform the method comprising:

establishing, via a criteria setting component, a criterion to filter unlikely collisions;

establishing, via a threshold setting component, a threshold associated with the criterion;

determining, via a position determining component, a position of the device at a first time;


determining, via a velocity determining component, a velocity of the device at the first time;

receiving, via a vector information receiving component, vector information associated with a communication device;
determining, via a collision determining component, a likelihood of collision between the
device and the communication device based on the established threshold, the received vector
information, the determined position and the determined velocity; and

providing, via a signal component, a signal associated with the likelihood of collision.

15. The non-transitory, tangible, computer-readable media of claim 14, the computer-
readable instructions being capable of being read by a computer and being capable of instructing
the computer to perform the method further comprising transmitting, via a transmitting
component, device vector information based on the determined position and the determined
velocity.

16. A non-transitory, tangible, computer-readable media of claim 14, wherein the computer-
readable instructions are capable of instructing the computer to perform the method such that
said establishing, via a criteria setting component, a criterion to filter unlikely collisions
comprises establishing the criterion to filter unlikely collisions as one of the group consisting of
day of year, day of week, time of day, geographic location, temperature, precipitation, ambient
brightness and combinations thereof.

17. A non-transitory, tangible, computer-readable media of claim 16, wherein the computer-
readable instructions are capable of instructing the computer to perform the method such that
said establishing the criterion to filter unlikely collisions as comprises establishing the
criterion to filter unlikely collisions as the time of day,

said establishing, via a threshold setting component, a threshold associated with the
criterion comprises establishing a time of day threshold, $t_{th}$, associated with the time of day
criterion such that $t_{th} < t_{sr} < t_{ss}$,

$t_{ss}$ is the time of the most recent sunset of the geographic location associated with the
position, and

$t_{sr}$ is the time of sunrise, after $t_{ss}$, of the geographic location associated with the position.
18. The non-transitory, tangible, computer-readable media of claim 11, the computer-readable instructions being capable of being read by a computer and being capable of instructing the computer to perform the method further comprising:

   establishing, via the criteria setting component, a second criterion to filter unlikely collisions as temperature of the geographic location associated with the position; and

   establishing, via the threshold setting component, a temperature threshold, $t_{\text{thtemp}}$, associated with the temperature criterion such that $t_{\text{thtemp}} < 32^\circ$ P.

19. A non-transitory, tangible, computer-readable media of claim 16, wherein the computer-readable instructions are capable of instructing the computer to perform the method such that

   said establishing the criterion to filter unlikely collisions as comprises establishing the criterion to filter unlikely collisions temperature of the geographic location associated with the position, and

   said establishing, via a threshold setting component, a threshold associated with the criterion comprises establishing a temperature threshold, $t_{\text{thtemp}}$, associated with the temperature criterion such that $t_{\text{thtemp}} < 32^\circ$ F.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/031062

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B60R 21/01; B60R 21/013; B60R 21/0132; B60R 21/0134 (2017.01)
CPC - B60R 21/01; B60R 21/013; B60R 21/0132; B60R 21/0134; B60R 2021/01 322 (2017.02)

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)

See Search History document

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

USPC - 180/271.000; 280/734.000; 280/735.000; 340/436.000; 701/36.000; 701/45.000; 701/301.000 (keyword delimited)

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>US 8,547,249 B2 (DAVID et al) 01 October 2013 (01.10.2013) entire document</td>
<td>1-19</td>
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<tr>
<td>Y</td>
<td>US 2013/0096731 A1 (TAMARI et al) 18 April 2013 (18.04.2013) entire document</td>
<td>4-7, 12, 13, 18, 19</td>
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<td>Y</td>
<td>WO 2008/093934 A1 (EO et al) 07 August 2008 (07.08.2008) entire document</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search
27 June 2017

Date of mailing of the international search report
19 JUL 2017

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## DOCUMENTS CONSIDERED TO BE RELEVANT

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