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(54) Title: MOBILE ASSET CELLULAR DEVICE TRANSMISSION DETECTION SYSTEM AND METHOD

(57) Abstract: This invention comprises a mobile asset cellular device transmission detector equipped, a wireless processing unit, an event recorder, and a digital video recorder. The wireless processing unit includes event recorder interface software, digital video recorder interface software that obtains data from the digital video recorder, Wi-Nav software that obtains data from the Wi-Nav, GPS software that obtains data from the GPS and geo-fence software. The cellular device transmission detector continually checks for cellular device transmissions within the mobile asset and if those transmissions were associated with an impact, rollover, operator action or geo-fence defined location or boundary. When a cellular device transmission was made, the wireless processing unit triggers an episode and sends event recorder information, GPS location and speed, audio and video recordings, and impact and rollover information to a back office.



## **Mobile Asset Cellular Device Transmission Detection System and Method**

[0001] This application claims priority to provisional application Ser. No. 61/875,737 filed September 10, 2013, to the extent allowed by law and to non-provisional application Ser. No. 14/481,290 filed September 9, 2014, to the extent allowed by law.

### **[0002] BACKGROUND OF THE INVENTION**

#### **[0003] Field of the Invention**

[0004] The present invention generally relates to equipment used in mobile assets and particularly, to cellular device detection systems used in value mobile assets.

#### **[0005] Description of the Prior Art**

[0006] Mobile assets such as locomotives, mining equipment, cargo, marine and military vehicles and vessels typically employ an onboard data acquisition and logging device, similar to a “black box” on airplanes. A typical onboard data acquisition and logging device, or an event/data recorder, comprises digital and analog inputs as well as pressure switches and transducers which record data from various onboard sensor devices. These event/data recorders log a variety of system parameters used for incident investigation, crew performance evaluation, fuel efficiency analysis, maintenance planning, and predictive diagnostics. Recorded data may include such parameters as speed, distance traveled, location, fuel level, engine revolutions per minute (RPM), fluid levels, operator controls, pressures, and temperature conditions. In addition to the basic event and operational data, video, still image and audio event/data recording capabilities are also deployed on many of these same

mobile assets. The data recorded onboard a mobile asset, wirelessly transmitted offboard can be triggered, prioritized and filtered based on the detection of cellular device usage.

[0007] A primary object of the present invention is to detect a transmitting cellular device in the cab of a mobile asset.

[0008] A further object of the present invention is to provide automatic collision detection during or within a configurable period of time after detection of a transmitting cellular device.

[0009] A further object of the present invention is to provide roll-over detection during or within a configurable period of time after detection of a transmitting cellular device.

[0010] A further object of the present invention is to provide audio and video recordings using onboard recording systems with one or multiple video and audio capture devices that monitor forward facing, rear facing and in-cab regions.

[0011] A further object of the present invention is to provide audio, still image and/or video recordings using onboard recording systems with one or multiple video and audio capture devices that monitor forward facing, rear facing and in-cab regions of a mobile asset nearby or adjacent to the mobile asset within which a transmitting cellular device was detected.

[0012] A further object of the present invention is to provide audio and video recordings using recording systems with one or multiple video, still image and audio capture devices with recording equipment from a fixed site nearby or adjacent to the mobile asset within which a transmitting cellular device was detected.

[0013] A further object of the present invention is to provide GPS location data to precisely locate the mobile asset at any time, including at a time of transmitting cellular device detection.

[0014] A further object of the present invention is to provide user-defined geo-fence geographical locations, regions, or boundaries where cellular device detection is disabled, enabled, or otherwise controlled.

[0015] A further object of the present invention is to provide user-defined rule sets where cellular device detection is disabled, enabled, or otherwise controlled. These rule sets may be based on regulatory, statutory, government, business, operational or safety requirements.

[0016] A further object of the present invention is to provide user-defined rule sets used in conjunction with user-defined geo-fences where cellular device detection is disabled, enabled, or otherwise controlled.

[0017] A further object of the present invention is use of a directional or omnidirectional receiving antenna within the mobile asset.

#### [0018] SUMMARY OF THE INVENTION

[0019] The mobile asset cellular device detection system and method of an embodiment of the present invention used on locomotives comprises the integration of four components. The components are an event data recorder (ER), similar to a “black box” on airplanes, a locomotive digital video recorder (LDVR), a wireless processing unit (Wi-PU), and a cellular device transmission detector and antenna. The Wi-PU includes two further components, a Wi-Nav and a global positioning system (GPS).

[0020] The Wi-PU also includes software that receives ER information, LDVR recordings, Wi-Nav information, GPS information, and geo-fence information. The ER information can include throttle position, brake pressures, wheel speed, emergency brake application, and

horn and bell operation. The GPS information can include the mobile asset's location, in latitude and longitude, heading, elevation and speed. The Wi-Nav information can include impact detection and rollover detection. Wi-Nav information can also include accelerometer data for dead reckoning location when GPS data is unavailable.

[0021] The cellular device transmission detector, can detect cellular devices that are powered on and transmitting, that includes when a cellular device within the mobile asset is being used to place a phone call, answer a phone call, send a text message, receive a text message, and any other data transmission such as email updates and browsing the internet. The cellular device transmission detector can also detect the operation of a portable cellular based Wi-Fi hotspot device. The user can also set a geo-fence area where cellular device usage is turned off or turned on, if the mobile asset is moving, stopped, or regardless of whether the mobile asset is moving.

#### [0022] BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The present invention is further described with reference to the accompanying drawings in which:

[0024] Fig. 1 is a diagram showing the system components of an embodiment of the mobile asset cellular device transmission detector of the present invention;

[0025] Fig. 2 is a flow diagram showing when a cellular device transmission is detected in the present invention;

[0026] Fig. 3 is a flow diagram showing the wireless processing unit checking the GPS onboard the mobile asset;

[0027] Fig. 4 is a flow diagram showing when a trigger episode has been detected within a geo-fence where cellular device transmission detection is enabled; and

[0028] Fig. 5 is a flow diagram showing when a trigger episode has been detected and user defined rules indicate that cellular device transmission detection is enabled.

#### [0029] DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0030] The mobile asset cellular device transmission detection system and method of the present invention and its components are shown in Fig. 1. The mobile asset cellular device transmission system 10 consists of five interrelated components: an event data recorder (ER) 12, a locomotive digital video recorder (LDVR) 14, a wireless processing unit (Wi-PU) 16, and a cellular device transmission detector and antenna 18. The cellular device transmission detector 18 can be within the Wi-PU 16 or outside of the Wi-PU 16. A Wi-Nav 20 component and a global positioning system (GPS) component 22 are within the Wi-PU 16. The Wi-PU 16 also includes ER 12 interface software 24, LDVR 14 interface software 26, Wi-Nav 20 software 28, GPS 22 software 30, geo-fence software 32 and user rules software 68. Installing the Wi-PU 16 onto an asset, such as a locomotive, consists of mounting the Wi-PU 16 with an external or internal cellular device transmission detector 18, and connecting it externally to an ER 12, an LDVR 14, a directional or omni-directional receiving antenna 67 and any additional available condition sensing devices.

[0031] The ER 12, similar to a black-box on airplanes, is an onboard data logging device for locomotives. A typical ER 12 consists of digital and analog inputs as well as pressure switches and pressure transducers which record data from various onboard devices, such as

throttle position, brake pressures, emergency brake application, and horn and bell application. The Wi-PU 16 receives and processes data from the ER 12 once per second over an external serial connection.

[0032] The LDVR 14, similar to a television DVR, is an onboard audio, still image and/or video recording device. The LDVR 14 comes equipped with a forward facing camera and may also include an in-cab facing camera, a rear facing camera, and microphones. The cameras are mounted at such orientations that they see and record what the engineer sees and the cab environment. The Wi-PU 16 accesses the LDVR 14 via an external Ethernet connection to download the audio, still image and/or video from the hard drive before, during, and after an event, such as when the cellular device transmission detector 18 detects that a cellular device is powered on and transmitting.

[0033] The Wi-PU 16 can use the geo-fence software 32 to set a geo-fence 33 that defines a geographic location, region or boundary within which the cellular device transmission detector 18 is to check for transmission or disregard a transmission detection. The geo-fence can be configurable to certain geographic locations 33. The geo-fence 33 can geographically define locations where cellular device detection is disabled, enabled or otherwise controlled.

[0034] The Wi-PU 16 can use the user rules software 68 to define specific rules under which the cellular device transmission detector 18 is to check for transmission or disregard a transmission detection. The user rules 68 define regulatory, statutory, government, business, operational or safety requirements where cellular device detection is disabled, enabled or otherwise controlled.

[0035] The Wi-PU 16 of the illustrated embodiment is a ruggedized onboard computer running Windows XP or a similar operating system embedded specifically for industrial

applications. It has many different features that can be installed to customize the product for specific customer needs. The Wi-PU 16 has the ability to communicate with a wide variety of onboard systems, including, but not limited to, vehicle control systems, event data recorders, LDVRs, cellular device transmission detectors, and engine controllers. The Wi-PU 16 has the ability to communicate over a wide variety of protocols, including, but not limited to, RS 232, RS 422, RS 485, CAN Bus, Ethernet, WiFi, cellular, and satellite.

[0036] The cellular device transmission detector 18, as is known in the art, can be an internal or external component of the Wi-PU 16. The cellular device transmission detector 18 detects several frequencies. In North America, the cellular device transmission detector 18 detects 1850 – 1910 MHz (PCS), 824 – 849 MHz (CDMA), 896 – 901 MHz (GSM), and 700 MHz (LTE). The cellular device transmission detector 18 has an adaptive sensitivity and can be optimized for the particular model of locomotive it is to be used on. The cellular device transmission detector 18 can be used with either a directional or omnidirectional receiving antenna 67.

[0037] Fig. 2 is a flow diagram showing when a cellular device transmission is detected in the present invention. The cellular device transmission detector 18 (Fig. 1) continually checks the cellular device transmission status 34 as received using the in cab antenna 67 (Fig. 1), checking if the cellular device is powered on and/or transmitting a signal 35. If the cellular device is not powered on and/or is not transmitting a signal 36, then the cellular device transmission detector continues to check the status 34. If the cellular device is powered on and/or is transmitting a signal 38, the cellular device transmission detector 18 alerts the Wi-PU 16 of the signal detection 40. The cellular device transmission detector 18 will detect cellular transmissions within the cab of a mobile asset. Transmissions include

placing a phone call, answering a phone call, sending a text message, receiving a text message, any data transmission (email updates, browsing the internet, etc.), and the operation of a portable cellular based Wi-Fi hotspot.

[0038] Fig. 3 is a flow diagram showing when a cellular device transmission has been detected. Once the Wi-PU 16 (Fig. 1) is alerted that a signal has been detected, the GPS software 30 (Fig. 1) checks the GPS 42 and obtains the mobile asset's location in latitude and longitude 44. The Wi-PU 16 then checks the geo-fence 46 and determines whether the location of the mobile asset is within that geo-fence 46 and whether the cellular device detection is disabled, enabled or otherwise controlled. If the location of the mobile asset is within the geo-fence 46 and cellular device detection is not enabled 50 within that geo-fence 46, the cellular device transmission detector 18 continues to check detector status 34 (Fig. 2). If the location of the mobile asset is within the geo-fence 46 and cellular device detection is enabled 52 or otherwise controlled, the Wi-PU 16 triggers an episode 54.

[0039] Fig. 4 is a flow diagram showing when a trigger episode 54 has been detected. When a trigger episode 54 has been detected, the ER information software 24 (Fig. 1) checks the ER information and the GPS software 30 (Fig. 1) checks the GPS and obtains the mobile asset's location in latitude and longitude, heading and speed 56. The Wi-PU 16 then sends the ER information and the GPS 22 location to the back office 58. The ER information can include throttle position, brake pressure, emergency brake application, horn and bell application. The back office uses GPS information to query, request and download audio, still images and/or video from other nearby mobile assets or fixed site video recording systems 73. The Wi-PU 16 then checks the Wi-Nav software 28 and determines whether an impact and/or a rollover occurred 60. The Wi-PU will then send the back office information

on whether cellular device transmission was detected, cellular device transmission was detected with an impact, and/or cellular device transmission was detected with a rollover 62. The Wi-PU 16 will also check the LDVR software 26 (Fig. 1) to obtain audio, still image and/or video recordings 64 of the trigger episode 54 and will send the audio/still image/video recording from the LDVR 14 for the time of the trigger episode 54 to the back office 66.

[0040] The back office uses the GPS 22 location information to determine other nearby or adjacent mobile assets equipped with an LDVR 14. The back office requests and receives still image and/or video data from an adjacent mobile asset's Wi-PU 16 with LDVR software 26.

[0041] The back office uses the GPS 22 location information to determine other nearby or adjacent fixed sites equipped with an LDVR 14. The back office requests and receives still image and/or video data from the fixed site LDVRs 14.

[0042] Fig. 5 is a flow diagram showing when cellular device transmission has been detected. Once the Wi-PU 16 (Fig. 1) is alerted that a signal has been detected, the Wi-PU checks the user defined rules 69 to determine whether the cellular device detection is disabled, enabled or otherwise controlled 70. If the user defined rules indicate that cellular device detection is not enabled 71, the cellular device transmission detector 18 continues to check detector status 34 (Fig. 2). If the user defined rules indicate that cellular device detection is enabled 72 or otherwise controlled, the Wi-PU 16 triggers an episode 54.

[0043] The foregoing description of an illustrated embodiment of the invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or to limit the invention to the precise form disclosed. The description was selected to best explain the principles of the invention and practical application of these principles to enable

others skilled in the art to best utilize the invention in various embodiments and various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention not be limited by the specification, but be defined by the claims set forth below.

What is claimed is:

1. A method for detecting cellular device transmission from a mobile asset, comprising the steps of:
  - a. a cellular device transmission detector onboard the mobile asset, said detector communicating with a wireless processing unit;
  - b. a global positioning system (GPS) within the wireless processing unit;
  - c. an event data recorder communicating with the wireless processing unit;
  - d. detecting transmission signals from the cellular device transmission detector;
  - e. obtaining GPS data for the mobile asset from the GPS;
  - f. determining whether transmission signals are within an area where transmissions are not allowed;
  - g. obtaining event data from the event data recorder onboard the mobile asset; and
  - h. sending the GPS data and the event data to a back office.
2. The method of claim 1, further comprising the steps of:
  - a. determining whether at least one of an impact and a rollover data of the mobile asset occurred; and
  - b. sending the at least one of the impact and rollover to the back office.
3. The method of claim 1, further comprising the step of:

- a. determining a location using dead reckoning when GPS data is not available
4. The method of claim 1, wherein the GPS data includes at least one of a location, a heading, and a speed of the mobile asset.
5. The method of claim 1, further comprising the steps of:
- a. obtaining at least one of audio, still image and video recordings from the digital video recorder from at least one of an adjacent mobile asset and an adjacent fixed site to the mobile asset upon which a transmitting cellular device was detected; and
  - b. sending at least one of the audio, still image and video recordings to the back office.
6. The method of claim 1 further comprising the steps of:
- a. a digital video recorder onboard the mobile asset communicating with the wireless processing unit;
  - b. obtaining at least one of audio, still image and video recordings from the digital video recorder; and
  - c. sending the event data from the event data recorder and the at least one of audio, still image, and visual recordings to the back office.
7. The method of claim 1, further comprising the step of:
- a. obtaining signals of cellular device operation from one of a directional and omnidirectional receiving antenna located in a cab of said mobile asset, said antenna localized to the volume of the cab.

8. The method of claim 1, further comprising the steps of:
  - a. comparing the detection of cellular device operation with one of regulatory and other mobile asset operating rules and restrictions at the back office; and
  - b. one of enabling and disabling detection based upon said comparison.
9. The method of claim 1, further comprising the steps of:
  - a. comparing the detection of cellular device operation with one of regulatory and other mobile asset operating rules and restrictions at the back office;
  - b. determining whether those transmission signals are subsequently within an area where transmissions are not allowed; and
  - c. one of enabling and disabling detection based upon said comparison and determination.
10. A method for detecting operation of a cellular device onboard a mobile asset, comprising the steps of:
  - a. one of a direction and an omnidirectional receiving antenna detecting a transmission status from the cellular device onboard the mobile asset;
  - b. a cellular device transmission detector onboard the mobile asset, said cellular device transmission detector continually checking the transmission status received from the antenna; and
  - c. a wireless processing unit receiving an indication from the cellular device transmission detector that the transmission status of the cellular device is operating.
11. The method of claim 10, wherein operating includes at least one of powered on, transmitting a signal, placing a phone call, answering a phone call, sending a text

message, receiving a text message, transmitting data, and operating a portable cellular based wi-fi hotspot.

12. The method of claim 10, wherein the transmission status includes at least one of the cellular device is powered on, the cellular device is powered off, the cellular device is transmitting a signal, and the cellular device is receiving a signal.
13. The method of claim 10, further comprising the steps of:
  - a. a global positioning system (GPS) software application checking a global positioning system (GPS) within the wireless processing unit onboard the mobile asset;
  - b. obtaining a first location of the mobile asset from the GPS;
  - c. the wireless processing unit comparing the first location to a predetermined geo-fence area; and
  - d. the wireless processing unit triggering an episode when the first location is within the predetermined geo-fence area and cellular device detection is one of enabled and controlled within the predetermined geo-fence area.
14. The method of claim 13, wherein the first location of the mobile asset includes latitude and longitude coordinates.
15. The method of claim 13, further comprising the steps of:
  - a. an event data recorder software application checking an event data recorder and obtaining event data recorder information;
  - b. the GPS software application obtaining GPS information of the mobile asset;
  - c. the wireless processing unit sending the event recorder information and the GPS information to a back office;

- d. the wireless processing unit determining whether at least one of an impact and a rollover occurred with the mobile asset;
  - e. the wireless processing unit requesting at least one of audio, still image, and video recordings from a digital video recorder onboard the mobile asset;
  - f. the wireless processing unit obtaining at least one of a cellular device transmission detection, an impact detection, a rollover detection, and at least one of the audio, still image, and video recordings; and
  - g. the wireless processing unit sending at least one of a cellular device transmission detection, an impact detection, a rollover detection, and at least one of the audio, still image, and video recordings to the back office.
16. The method of claim 15, wherein the GPS information includes at least one of a second location, a heading, and a speed of the mobile asset.
17. The method of claim 16, wherein the second location of the mobile asset includes latitude and longitude coordinates.
18. The method of claim 17, wherein the back office uses the GPS information to locate at least one of an adjacent mobile asset and an adjacent fixed site.
19. The method of claim 18, wherein the back office queries, requests, and downloads at least one of audio, still image, and video recordings from at least one of the adjacent mobile asset and the adjacent fixed site.
20. The method of claim 10, further comprising the steps of:
- a. the wireless processing unit checking a set of user-defined rules;
  - b. the wireless processing unit triggering an episode when the set of user-defined rules indicate cellular device detection is one of enabled and controlled.

21. The method of claim 20, further comprising the steps of:

- a. an event data recorder software application checking the event data recorder and obtaining event data recorder information;
- b. the global positioning system (GPS) software application obtaining global positioning system (GPS) information of the mobile asset;
- c. the wireless processing unit sending the event recorder information and the GPS information to a back office;
- d. the wireless processing unit determining whether at least one of an impact and a rollover occurred with the mobile asset;
- e. the wireless processing unit requesting at least one of audio, still image, and video recordings from a digital video recorder onboard the mobile asset;
- f. the wireless processing unit obtaining at least one of a cellular device transmission detection, an impact detection, a rollover detection, and at least one of the audio, still image, and video recordings; and
- g. the wireless processing unit sending at least one of a cellular device transmission detection, an impact detection, a rollover detection, and at least one of the audio, still image, and video recordings to the back office.

22. The method of claim 21, wherein the GPS information includes at least one of a second location, a heading, and a speed of the mobile asset.

23. The method of claim 22, wherein the second location of the mobile asset includes latitude and longitude coordinates.

24. The method of claim 21, wherein the back office uses the GPS information to locate at least one of an adjacent mobile asset and an adjacent fixed site.

25. The method of claim 24, wherein the back office queries, requests, and downloads at least one of audio, still image, and video recordings from at least one of the adjacent mobile asset and the adjacent fixed site.
26. The method of claim 1, wherein the event data includes at least one of throttle position, brake pressure, emergency brake application, and horn and bell application of the mobile asset.
27. The method of claim 3, wherein the location includes latitude and longitude coordinates.
28. The method of claim 4, wherein the location includes latitude and longitude coordinates.
29. The method of claim 15, wherein the event data recorder information includes at least one of throttle position, brake pressure, emergency brake application, and horn and bell application of the mobile asset.
30. The method of claim 21, wherein the event data recorder information includes at least one of throttle position, brake pressure, emergency brake application, and horn and bell application of the mobile asset.
31. A system for detecting operation of a cellular device onboard a mobile asset, comprising:
- a. a wireless processing unit onboard the mobile asset;
  - b. one of a directional and an omnidirectional receiving antenna onboard the mobile asset, said antenna communicating with the wireless processing unit;
  - c. a cellular device transmission detector onboard the mobile asset, said detector communicating with the antenna and the wireless processing unit;
  - d. a digital video recorder for recording at least one of audio, still images, and video recordings, said digital video recorder communicating with the wireless processing unit;

- e. an event data recorder for recording at least one of throttle position, brake pressure, emergency brake application, and horn and bell application of the mobile asset, said event data recorder communicating with the wireless processing unit;
- f. an event data recorder interface software within the wireless processing unit, said event data recorder interface software communicating with the event data recorder;
- g. a digital video recorder interface software within the wireless processing unit, said digital video recorder interface software communicating with the digital video recorder;
- h. a wi-nav within the wireless processing unit within the wireless processing unit, said wi-nav determining whether one of an impact and a rollover occurred with the mobile asset;
- i. a wi-nav software application within the wireless processing unit, said wi-nav software communicating with the wi-nav;
- j. a global positioning system (GPS) within the wireless processing unit, said GPS for receiving GPS information of the mobile asset;
- k. a global positioning system (GPS) software application within the wireless processing unit, said GPS software application communicating with the GPS;
- l. a geo-fence software application within the wireless processing unit; and
- m. a user rules software application within the wireless processing unit.

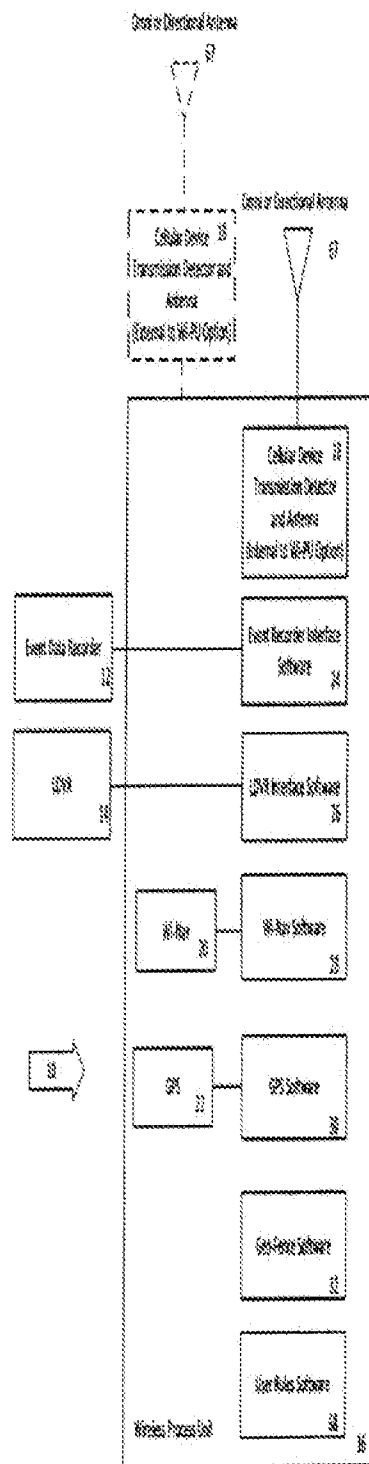


Figure 1

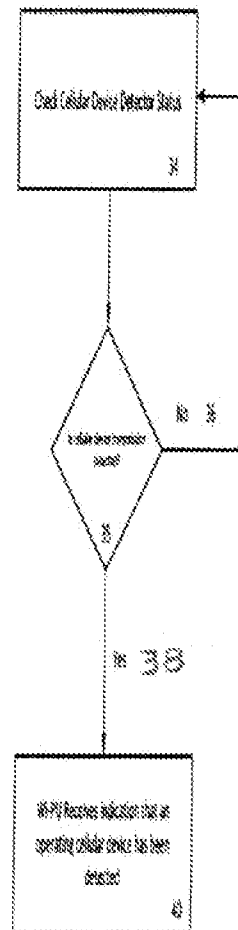


Figure 2

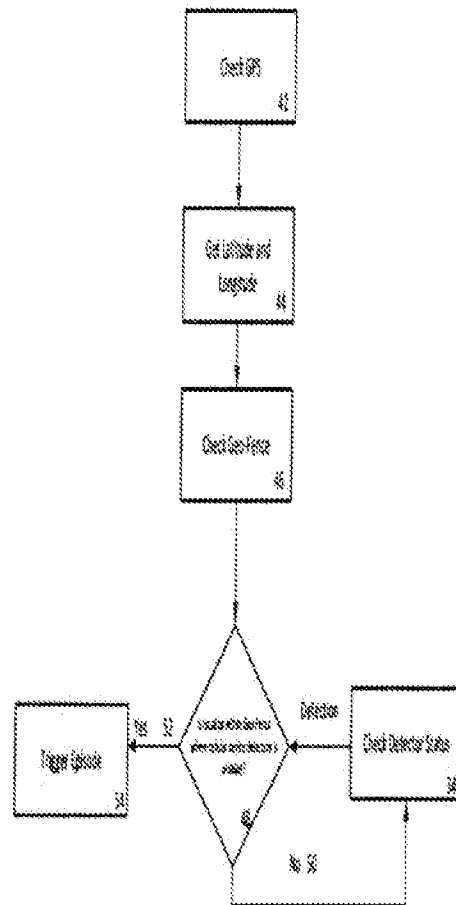


Figure 3

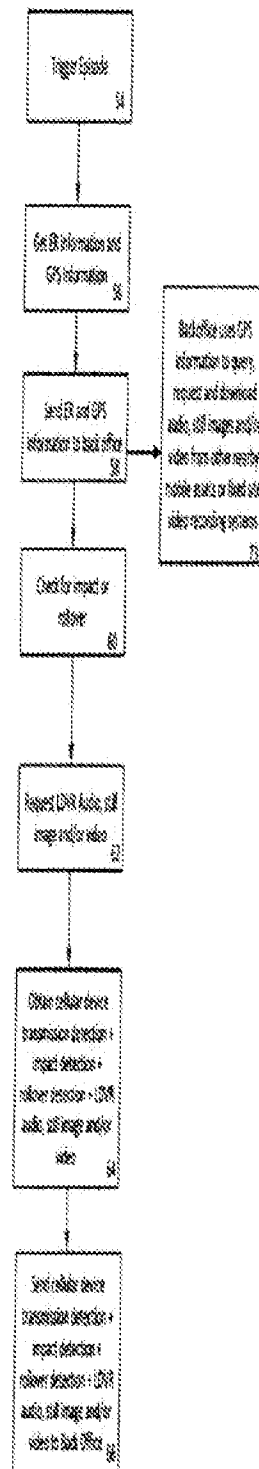


Figure 1

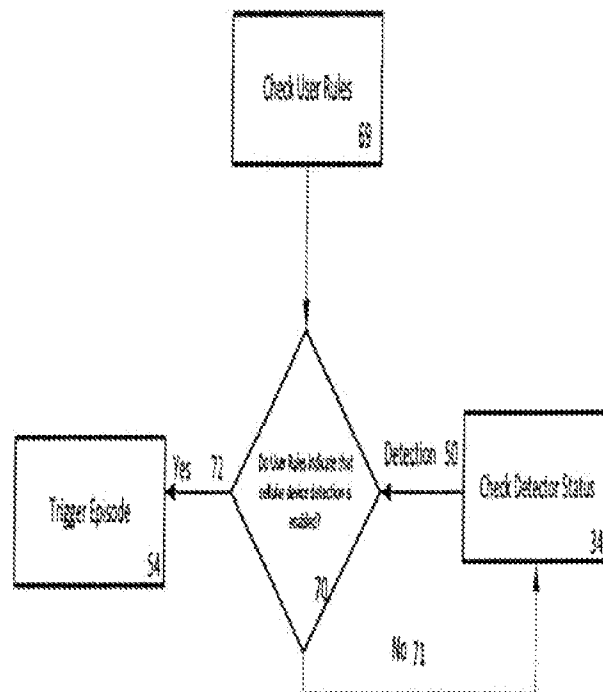


Figure 5

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/54768

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H04W 24/00 (2014.01)

CPC - H04W 64/00

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8): H04W 24/00 (2014.01)

CPC: H04W 64/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
USPC: 340/572.1, 455/456.1 (keyword limited - see terms below)

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

PatBase; GOOGLE; GoogleScholar; GooglePatents

Search Terms: tracking asset, GPS, location, heading, speed mobile asset, transmission, receive, dead reckoning, speed, velocity, acceleration, on-board, impact, roll-over, geofence, latitude, longitude

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/0275281 A1 (Rosen) 05 November 2009 (05.11.2009), entire document, especially; abstract, para. [0006], [0016], [0031], [0036], [0037]	1 - 31
Y	US 2012/0028680 A1 (Breed) 02 February 2012 (02.02.2012), entire document, especially; abstract, para. [0174], [0178], [0181], [0289], [0306], [0334], [0335], [0420], [0469], [0494]	1 - 31
A	US 2002/0177476 A1 (Chou) 28 November 2002 (28.11.2002), entire document	1 - 31
X, P	US 2013/0238366 A1 (Morgan et al.) 12 September 2013 (12.09.2013), entire document	1 - 31

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

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