Title: CHILD VEHICLE SEAT OCCUPANCY SENSOR

Abstract: Methods and systems for detection of child vehicle seats may be used to indicate presence or absence of a child in a child seat within a vehicle. In some examples, an alarm system includes a radio frequency (RF) transceiver and a child seat with an occupancy sensor integrated into the seat to determine whether the seat is occupied. Various actions are triggered when the parent (e.g., guardian) goes beyond a predefined range while the child seat is occupied, such as sounding an alarm on a mobile electronic device.
CHILD VEHICLE SEAT OCCUPANCY SENSOR

BACKGROUND

Due to rapidly increasing temperatures within a locked vehicle, children left in vehicles run a high risk of heat exhaustion or death. Existing solutions for child detection rely on weight sensors, however these weight sensors require weight calibration.

SUMMARY

Methods and systems for detection of child vehicle seats may be used to indicate presence or absence of a child in the vehicle. In some examples, an alarm system includes a radio frequency (RF) transceiver and a child seat with an integrated occupancy sensor. Various actions are triggered when the parent (e.g., guardian) goes beyond a predefined range while the occupancy sensor indicates the child seat is occupied, such as sounding an alarm on a mobile electronic device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a child vehicle seat occupancy detection and notification system, according to some embodiments.

FIG. 2 is a block diagram of an occupancy sensor system, according to some embodiments.

FIG. 3 is a flowchart of a child vehicle seat occupancy detection method, according to some embodiments.

FIG. 4 is a block diagram of a computer system to implement a child vehicle seat occupancy detection system, according to some embodiments.

DETAILED DESCRIPTION

In the following description, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific embodiments that may be practiced. These embodiments are described in
sufficient detail to enable those skilled in the art to practice the invention, and it is to
be understood that other embodiments may be used and that structural, logical, and
electrical changes may be made without departing from the scope of the present
invention. The following description of example embodiments is, therefore, not to
be taken in a limited sense, and the scope of the present invention is defined by the
append claims.

The functions or algorithms described herein may be implemented in
software or a combination of software and human implemented procedures in one
embodiment. The software may consist of computer executable instructions stored
on computer readable media such as memory or other type of storage devices.
Further, such functions correspond to specifically programmed modules, which are
software, hardware, firmware, or any combination thereof. Multiple functions may
be performed in one or more modules as desired, and the embodiments described
are merely examples. The software may be executed on a digital signal processor,
ASIC, microprocessor, or other type of processor operating on a computer system,
such as a personal computer, server, or other computer system.

Described herein are methods and systems for alerting a parent based on
occupancy of a child vehicle seat. The child vehicle seat occupancy system may
include an enclosure containing a hardware occupancy sensor circuit, a controller
circuit, and a radio frequency (RF) communication circuit. In some embodiments,
the transmitter communicates with a mobile electronic device, detects proximity to
the device, and causes the mobile electronic device to generate an abandonment
alert.

FIG. 1 is a perspective view of a child vehicle seat occupancy detection and
notification system 100, according to some embodiments. System 100 includes a
child seat 110 and a mobile electronic device 120, such as a smartphone. The child
seat may include a sensor 130, and the sensor 130 may generate an occupancy
signal to indicate that a child in close proximity with the sensor 130. The sensor
130 includes a processor 140 and an RF communication circuit 150. In various
examples, the sensor 130, via the RF circuit 150, transmits occupancy signals to the
mobile electronic device 120, to a vehicle computer system, or to another device.
The RF circuit may transmit signals in accordance with a low power wireless transmission standard, such as Bluetooth Low Energy (BTLE), IEEE 802.15.1, IEEE 802.15.4, or other standards. The RF circuit 150 may be paired with one or more of the mobile electronic device 120 or with a vehicle to establish such communications.

In some embodiments, the sensor 130 receives a raw occupancy sensor measurement, interprets the raw measurement as an estimated distance or binary occupancy signal, formats the interpreted data, and transmits the formatted data. For example, a raw occupancy sensor measurement may include a voltage level received from an inductive wire loop sensor, and the voltage level may be compared against a voltage threshold to generate a binary occupancy signal indicating that the seat 110 is occupied. In other embodiments, the sensor 130 receives and transmits the raw measurement to the device 120, and the device 120 interprets the raw measurement. In still other embodiments, the sensor 130 receives and interprets the raw measurement, and transmits both the raw measurement and the interpreted measurement to the device 120. The raw and interpreted measurements may be received by the processor 140 and converted into a data format that is compatible with the target device, such as using a data format compatible with an application running on the mobile device 120 or a data format compatible with a vehicle computer system.

The occupancy signal may be received by device 120, and an application running on device 120 may indicate whether the child is in close proximity with the sensor 130. The occupancy signal may be used to display whether the seat 110 is occupied. For example, the application on device 120 may receive a binary occupancy signal and present a computer-generated image of a child within a child vehicle seat.

FIG. 2 is a block diagram of an occupancy sensor system 200, according to some embodiments. System 200 may be implemented using a mobile device processor, a dedicated integrated circuit (IC), or other circuit components. System 200 may include an occupancy sensor 210. The occupancy sensor 210 may indicate a change in proximity, where the indication is in the form of a change in an
5 electrical characteristic. For example, the occupancy sensor 210 may provide a change in voltage, capacitance, inductance, or other electrical characteristic. The occupancy sensor 210 may include a complex sensor such as a dedicated proximity sensing integrated circuit, or may include a simple sensor such as a wire loop 215. The use of a wire loop or other simple sensor may reduce manufacturing complexity and improve reliability. For example, a wire loop 215 may be electrically connected to or integrated within a switched capacitor circuit in occupancy sensor 210. A baseline capacitance may be measured using the wire loop 215, where the baseline capacitance includes the parasitic capacitance of the wire loop 215, surrounding electronics, the child vehicle seat structure, and other nearby structures. When a child is placed in the child vehicle seat in proximity to the wire loop 215, the child and wire loop 215 combine to form a parallel plate capacitor with associated capacitance, and the capacitance measured at the occupancy sensor 210 includes the sum of the parasitic capacitance and the parallel plate capacitance. The capacitance changes may be detected using various techniques, such as using the analog to digital converter 220 described below.

System 200 may include an analog to digital converter (ADC) 220. The ADC 220 may convert a signal from the occupancy sensor 210 into one or more voltage levels indicative of a change in occupancy or proximity. To detect seat occupancy, a current source may be used to generate a linear voltage ramp on the capacitor within the occupancy sensor 210, and the voltage output may be fed into the ADC 220. The ADC 220 may include a comparator and a counter, where the counter increments whenever the comparator output transitions from high to low. The counter output of the ADC 220 may be tracked over time. A lower frequency of counts may be associated with a baseline occupancy counter frequency that indicates an unoccupied child seat. Conversely, a higher frequency of counts may be associated with an occupied child seat. The count frequencies associated with the unoccupied and occupied child seat may be static or variable values, any may be adjusted (e.g., tuned) manually or automatically to ensure detection of an occupied child seat.
The ADC 220 may include a delta-sigma modulator, a filter, or other components. For example, the ADC 220 may perform delta modulation to encode the change in signal over time, integrate the modulated signal, sample the integrated signal, filter the sampled signal, and decimate the filtered signal.

Though system 200 is described using an ADC 220, other capacitive and non-capacitive sensing methods may be used. In addition or alternative to the ADC, system 200 may use one or more other capacitive sensing methods. In some embodiments, the wire loop capacitance value may be converted into a resistance value, and a voltage may be applied to the resistance value to monitor changes in loop capacitance. The voltage may have an associated static value, may have an associated periodic waveform, or may be a shaped waveform input. In an example, the change in capacitance may be detected through charge transfer, where the change in capacitance due to the child modifies the charge transfer between a sensor capacitor and reference capacitor, where incremental charge packets are transferred until reaching a predetermined occupancy threshold voltage on the reference capacitor. In another example, a sensor capacitor is used to detect a child by detecting a change in frequency of an oscillator by detecting an increase in sensor capacitance or decrease in oscillator frequency. In another example, a source waveform is driven as an input, and the occupancy is detected by the change in capacitance and the associated change to the waveform output. Various methods may be used in the alternative or in combination.

The system may include a microprocessor 230. The microprocessor 230 may receive digital signals from the ADC 220 representative of various occupancy measurements. The microprocessor 230 may also receive information from other external sensors, such as a temperature sensor 240, an impact sensor 250, a Bluetooth radio 260, or from other sensors. The microprocessor 230 may receive RF proximity signals from Bluetooth radio 260 via a Bluetooth antenna 265, where the RF proximity signals indicate RF proximity between the Bluetooth radio 260 and an external mobile electronic device. The microprocessor 230 may also use the Bluetooth radio 260 to communicate with the external mobile electronic device, including sending or receiving alerts or occupancy or proximity information.
Components of the occupancy sensor system 200 may be implemented on two or more devices. In an example, a child vehicle seat may be manufactured to include occupancy sensor 210, ADC 220, microprocessor 230, temperature sensor 240, impact sensor 250, and Bluetooth radio 260. In other embodiments, some or all of the system components may be implemented in a mobile electronic device, in a vehicle, or in another device.

The microprocessor 230 may generate an alert based on signals received from any one sensor. For example, the microprocessor 230 may receive a signal from the ADC 220, compare the signal to a threshold, and provide an alert based on whether the seat is occupied. The microprocessor 230 may generate an alert based on a combination of signals received from multiple sensors. For example, the microprocessor 230 may determine a seat is occupied based on a received signal from the ADC 220, determine that a parent’s Bluetooth device has moved beyond a threshold based on a received signal strength indicator (RSSI) from the Bluetooth radio 260, and generate an alert that indicates the seat is occupied and unsupervised.

In another example, an alert may be generated if the seat is occupied and the temperature sensor 240 indicates the temperature exceeds a threshold, or if the seat is occupied and the impact sensor 250 indicates that the vehicle has been involved in a collision.

The microprocessor 230 may generate a conventional alert that is sent to a mobile device. Because some alerts are based on the mobile device proximity exceeding a threshold, the proximity threshold may be configured such that the alert is generated and sent before the device is out of range of the Bluetooth radio 260. Additional radios may be used to convey an alert. For example, an alert may be generated when the seat is occupied and the mobile device is out of range of the Bluetooth radio 260, where the alert is transmitted to the mobile device via Wi-Fi, cellular data, or another radio signal. In addition to the conventional alert sent to the mobile device, the microprocessor 230 may also generate an alert suppression signal that causes the mobile device to alert the user whenever the suppression signal is lost. For example, the mobile device may detect an occupied seat and send an alert suppression signal to the mobile device, and the mobile device may generate an alert
when the mobile device is out of range of the alert suppression signal. The conventional alert signal and suppression signal may be used in the alternative or in combination to ensure the user is alerted.

FIG. 3 is a flowchart of a child vehicle seat occupancy detection method 300, according to some embodiments. Method 300 may be executed on a device processor that has been specifically programmed or designed to carry out method steps. Method 300 may include determining baseline occupancy signal characteristics 310. The occupancy signal may include a voltage level generated by an occupancy sensor. The baseline occupancy characteristics may include a voltage that corresponds to an unoccupied child vehicle seat. Determining the baseline occupancy signal characteristics 310 may occur when the child vehicle seat is manufactured, when the child vehicle seat is first used, or each time a child is removed from the child vehicle seat. A single baseline voltage may be stored for later comparison, or multiple historic baseline voltages may be stored for analysis, calibration, or troubleshooting purposes.

Method 300 may include determining occupancy via capacitive sensing 320. Determining occupancy via capacitive sensing 320 may be based on the baseline occupancy signal characteristics. For example, the baseline signal may be compared to a new occupancy capacitive sensing voltage, and a change in capacitive sensing voltage that exceeds a threshold may be used to detect or indicate occupancy of the seat. The determination of occupancy may be with respect to absolute sensor values. For example, voltage levels for an unoccupied seat and for an occupied seat may be set to specific values, and those values may be used for occupancy detection. The determination of occupancy may be with respect to relative or variable sensor values. Voltage levels for an unoccupied seat and for an occupied seat may be determined each time a child is placed into the seat. For example, when a voltage change of at least one volt is detected, then the voltage level before the change is associated with an unoccupied seat state and the voltage level after the change is associated with an occupied seat state. This dynamic update would allow the system to compensate for capacitive or voltage level fluctuations due to clothing, humidity, temperature, or other external factors. A
hysteresis may be used to improve occupancy detection or reduce false alarms. For example, if three volts corresponds to an unoccupied seat and five volts corresponds to an occupied seat, then the seat state may not transition from occupied to unoccupied until the voltage level drops below four volts. The voltage values may be static, variable, user-configurable, or otherwise adjustable. Though various embodiments are described herein with respect to capacitive sensing, other occupancy sensor technologies may be used.

Method 300 includes determining that a mobile device distance exceeds a threshold 330. After determining that a seat is occupied, a mobile electronic device proximity may be monitored to determine if the mobile electronic device has moved beyond an abandonment threshold while the child vehicle seat is occupied. The mobile electronic device proximity may be based on a detected signal power, a received signal strength indicator (RSSI), lost connection detection, presence or absence of an RF signal, or other RF signal characteristics. In some examples, location information may be used to determine an RF proximity, such as using GPS information, cellular tower triangulation, Wi-Fi access point triangulation, or other location information. The proximity indication may be generated by an RF circuit. The RF circuit may be configured to communicate based on a wireless communication standard, wherein the wireless communication standard is based on at least one of a BTLE standard, an IEEE 802.15.1 standard, and an IEEE 802.15.4 standard. Based on a combination of determining occupancy via capacitive sensing 320 and determining that a mobile device distance exceeds a threshold 330, method 300 may generate 340 an abandonment alert.

Method 300 may include determining that an environmental measurement exceeds a maximum environmental measurement safety threshold 350. The environmental measurement may be received by an environmental sensor, an impact sensor, or other sensor. Based on a combination of determining occupancy via capacitive sensing 320 and determining that an environmental measurement exceeds a maximum environmental measurement safety threshold 350, method 300 may generate 360 an environment alert.
Method 300 includes notifying the user of an alert 370. An alert may be generated and a user notified when the seat is occupied and the mobile device is out of range. As described above, a conventional alert signal or an alert suppression signal may be generated, where the mobile device may generate an alert when the mobile device is out of range of the alert suppression signal. The alert may be transmitted via an RF circuit to a mobile electronic device such as a smartphone, to a vehicle, or to another electronic device. In some examples, notifying 370 includes causing a mobile electronic device to flash, vibrate, play a sound, display a warning message, send a text or e-mail message, and other forms of notification. In some examples, notifying 370 includes causing a vehicle alarm system to honk a horn, flash vehicle lights, or provide other vehicular notification. Various forms of notification may be combined to increase the probability that a user is notified.

In some embodiments, one or more operations of method 300 may be performed by the mobile device 120, which may receive occupancy information from system 200 via one or more wireless connections, such as via Bluetooth radio 260. The application running on the mobile device may use the occupancy information and signal strength to trigger an alert, or may use an indication of a lost Bluetooth connection to trigger an alert.

FIG. 4 is a block schematic diagram of a computer system 400 to implement a child vehicle seat occupancy detection system, according to some embodiments. The computer system 400 may use fewer components than shown in FIG. 4 in some embodiments to perform the methods described. One example computing device in the form of a computer 400, may include a processing unit 402, memory 403, removable storage 410, and non-removable storage 412. Memory 403 may include volatile memory 414 and non-volatile memory 408. Computer 400 may include – or have access to a computing environment that includes – a variety of computer-readable media, such as volatile memory 414 and non-volatile memory 408, removable storage 410 and non-removable storage 412. Computer storage includes random access memory (RAM), read only memory (ROM), erasable programmable read-only memory (EPROM) & electrically erasable programmable read-only memory (EEPROM), flash memory or other memory technologies, compact disc
read-only memory (CD ROM), Digital Versatile Disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium capable of storing computer-readable instructions. Computer 400 may include or have access to a computing environment that includes input 406, output 404, and a communication connection 416. The computer may operate in a networked environment using a communication connection to connect to one or more remote computers, such as database servers. The remote computer may include a personal computer (PC), server, router, network PC, a peer device or other common network node, or the like. The communication connection may include a Local Area Network (LAN), a Wide Area Network (WAN) or other networks.

Computer-readable instructions stored on a computer-readable medium are executable by the processing unit 402 of the computer 400. A hard drive, CD-ROM, and RAM are some examples of articles including a non-transitory computer-readable medium. For example, a computer program 418 capable of providing a generic technique to perform access control check for data access and/or for doing an operation on one of the servers in a component object model (COM) based system may be included on a CD-ROM and loaded from the CD-ROM to a hard drive. The computer-readable instructions allow computer 400 to provide generic access controls in a COM based computer network system having multiple users and servers.

The present disclosure supports several examples, including but not limited to the following examples.

Example 1 is a child seat occupancy detection system, the system comprising a child seat occupancy detection sensor; a radio frequency (RF) circuit, the RF circuit configured to communicate with a mobile electronic device; and a device processor electrically coupled to the occupancy sensor and to the RF circuit, the device processor specifically programmed to: receive a baseline occupancy signal from the occupancy sensor, the baseline occupancy signal representative of an empty child seat; receive an operational occupancy signal from the occupancy sensor; determine that a difference between the baseline occupancy signal and the
operational occupancy signal exceeds an occupancy signal threshold, the occupancy signal threshold representative of an occupied seat; receive an RF proximity indication from the RF circuit, the RF proximity indication representative of a device distance between the RF circuit and the mobile electronic device; determine, based on the RF proximity indication, that the device distance exceeds a maximum device distance threshold; and generate an abandonment alert, the alert indicating that the child seat is occupied and that the device distance exceeds the maximum device distance threshold.

In Example 2, the subject matter of Example 1 optionally further includes wherein the child seat occupancy detection sensor includes a capacitive occupancy sensor, the capacitive sensor configured to be sensitive to a human proximity.

In Example 3, the subject matter of any one or more of Examples 1–2 optionally further includes wherein the capacitive occupancy sensor includes a wire loop.

In Example 4, the subject matter of any one or more of Examples 1–3 optionally further includes wherein the capacitive occupancy sensor is integrated into a child vehicle seat.

In Example 5, the subject matter of any one or more of Examples 1–4 optionally further includes wherein the capacitive occupancy sensor is integrated into a padding of the child vehicle seat.

In Example 6, the subject matter of any one or more of Examples 1–5 optionally further includes wherein the capacitive occupancy sensor is integrated into a molding of the child vehicle seat.

Example 7 is a method for child seat occupancy detection, the method comprising receiving a baseline occupancy signal from a child seat occupancy detection sensor, the baseline occupancy signal representative of an empty child seat; receiving an operational occupancy signal from the occupancy sensor; determining that a difference between the baseline occupancy signal and the operational occupancy signal exceeds an occupancy signal threshold, the occupancy signal threshold representative of an occupied seat; receiving an RF proximity indication from a radio frequency (RF) circuit, the RF proximity indication
representative of a device distance between the RF circuit and a mobile electronic
device; determining, based on the RF proximity indication, that the device distance
exceeds a maximum device distance threshold; and generating an abandonment
alert, the alert indicating that the child seat is occupied and that the device distance
exceeds the maximum device distance threshold.

In Example 8, the subject matter of Example 7 optionally further includes
determining the occupancy signal threshold based on a comparison between the
baseline occupancy signal and the operational occupancy signal.

In Example 9, the subject matter of any one or more of Examples 7–8
optionally further includes sending the abandonment alert to the mobile electronic
device.

In Example 10, the subject matter of any one or more of Examples 7–9
optionally further includes sending the abandonment alert to a vehicle alarm system.

In Example 11, the subject matter of any one or more of Examples 7–10
optionally further includes wherein receiving the operational occupancy signal
includes receiving a capacitive signal from a capacitive occupancy sensor within the
child seat occupancy detection sensor, the capacitive sensor configured to be
sensitive to a human proximity.

In Example 12, the subject matter of any one or more of Examples 7–11
optionally further includes wherein the capacitive occupancy sensor includes a wire
loop.

In Example 13, the subject matter of any one or more of Examples 7–12
optionally further includes wherein the capacitive occupancy sensor is integrated
into a child vehicle seat.

In Example 14, the subject matter of any one or more of Examples 7–13
optionally further includes wherein the capacitive occupancy sensor is integrated
into a padding of the child vehicle seat.

In Example 15, the subject matter of any one or more of Examples 7–14
optionally further includes wherein the capacitive occupancy sensor is integrated
into a molding of the child vehicle seat.
Although a few embodiments have been described in detail above, other modifications are possible. For example, the logic flows depicted in the figures do not require the particular order shown, or sequential order, to achieve desirable results. Other steps may be provided, or steps may be eliminated, from the described flows, and other components may be added to, or removed from, the described systems. Other embodiments may be within the scope of the following claims.
CLAIMS

1. A child seat occupancy detection system, the system comprising:
   a child seat occupancy detection sensor;
   a radio frequency (RF) circuit, the RF circuit configured to communicate
   with a mobile electronic device; and
   a device processor electrically coupled to the occupancy sensor and to the
   RF circuit, the device processor specifically programmed to:
      receive a baseline occupancy signal from the occupancy sensor, the
      baseline occupancy signal representative of an empty child seat;
      receive an operational occupancy signal from the occupancy sensor;
      determine that a difference between the baseline occupancy signal
      and the operational occupancy signal exceeds an occupancy signal threshold,
      the occupancy signal threshold representative of an occupied seat;
      receive an RF proximity indication from the RF circuit, the RF
      proximity indication representative of a device distance between the RF
      circuit and the mobile electronic device;
      determine, based on the RF proximity indication, that the device
      distance exceeds a maximum device distance threshold; and
      generate an abandonment alert, the alert indicating that the child seat
      is occupied and that the device distance exceeds the maximum device
      distance threshold.

2. The system of claim 1, wherein the child seat occupancy detection sensor
   includes a capacitive occupancy sensor, the capacitive sensor configured to be
   sensitive to a human proximity.

3. The system of any one of claims 1 to 2, wherein the capacitive occupancy
   sensor includes a wire loop.
4. The system of any one of claims 1 to 2, wherein the capacitive occupancy sensor is integrated into a child vehicle seat.

5. The system of any one of claims 1 to 4, wherein the capacitive occupancy sensor is integrated into a padding of the child vehicle seat.

6. The system of any one of claims 1 to 4, wherein the capacitive occupancy sensor is integrated into a molding of the child vehicle seat.

7. A method for child seat occupancy detection, the method comprising:
   receiving a baseline occupancy signal from a child seat occupancy detection sensor, the baseline occupancy signal representative of an empty child seat;
   receiving an operational occupancy signal from the occupancy sensor;
   determining that a difference between the baseline occupancy signal and the operational occupancy signal exceeds an occupancy signal threshold, the occupancy signal threshold representative of an occupied seat;
   receiving an RF proximity indication from a radio frequency (RF) circuit, the RF proximity indication representative of a device distance between the RF circuit and a mobile electronic device;
   determining, based on the RF proximity indication, that the device distance exceeds a maximum device distance threshold; and
   generating an abandonment alert, the alert indicating that the child seat is occupied and that the device distance exceeds the maximum device distance threshold.

8. The method of claim 7, further including determining the occupancy signal threshold based on a comparison between the baseline occupancy signal and the operational occupancy signal.

9. The method of claim 7, further including sending the abandonment alert to the mobile electronic device.
10. The method of claim 7, further including sending the abandonment alert to a vehicle alarm system.

11. The method of claim 7, wherein receiving the operational occupancy signal includes receiving a capacitive signal from a capacitive occupancy sensor within the child seat occupancy detection sensor, the capacitive sensor configured to be sensitive to a human proximity.

12. The method of any one of claims 7 to 11, wherein the capacitive occupancy sensor includes a wire loop.

13. The method of any one of claims 7 to 11, wherein the capacitive occupancy sensor is integrated into a child vehicle seat.

14. The method of any one of claims 7 to 13, wherein the capacitive occupancy sensor is integrated into a padding of the child vehicle seat.

15. The method of any one of claims 7 to 13, wherein the capacitive occupancy sensor is integrated into a molding of the child vehicle seat.
FIG. 2
FIG. 3

310 Determine baseline occupancy signal characteristics
320 Determine occupancy by capacitive sensing
330 Determine mobile device distance exceeds threshold
340 Generate abandonment alert
350 Determine environmental measurement exceeds threshold
360 Generate environmental alert
370 Notify user of alert
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 2015/060903

A. CLASSIFICATION OF SUBJECT MATTER

B60N 2/26 (2006.01)
B60Q 9/00 (2006.01)

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)

B60N 2/00, 2/24-2/32, B60Q 1/00, 9/00, B60R 21/00-21/08, 22/00-22/10

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

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

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPi, EAPATIS, PATENTSCOPE, Information Retrieval System of FIPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<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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<tbody>
<tr>
<td>Y</td>
<td>RU 153000 U1 (KLIMENKOV MAKSIM SERGEIEVICH) 27.06.2015, page 2, lines 1-4, 20-22, 29-47</td>
<td>1-15</td>
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<tr>
<td>Y</td>
<td>US 2005/0121885 A1 (ELESYS NORTH AMERICA, INC.) 09.06.2005, abstract, [0008]-[0009], [0017]-[0019], [0026]-[0068], fig.1-6</td>
<td>1-15</td>
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<tr>
<td>Y</td>
<td>US 2008/0129482 A1 (KOJI SEGUCHI et al.) 05.06.2008, [0075]-[0076], claim 1</td>
<td>3, 12</td>
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<td>US 2013/0106598 A1 (ORLANDO L. SILVEIRA) 02.05.2013, abstract, [0003], [0009], [0011], [0018]-[0020], [0022]-[0023], [0025], [0028]-[0031], fig.1-5</td>
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</table>

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

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Date of the actual completion of the international search

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Date of mailing of the international search report

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