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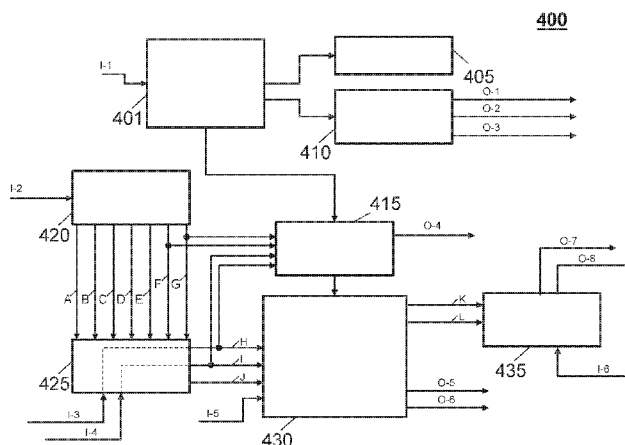


FIG. 4

(57) Abstract: The disclosure herein relates to a method, system, and/or a computer program product for determining an allowable propulsion torque modification. Determining an allowable propulsion torque modification can be performed by a vehicle dynamics influencing controller that modifies first and second axle torques based on a vehicle dynamics condition to generate modified first and second axle torques and utilizes the modified first and second axle torques to calculate a maximum request torque modification yaw disturbance. Further, the vehicle dynamics influencing controller can, in accordance with whether a vehicle dynamics allowed yaw propulsion target is greater than or equal to maximum request torque modification yaw disturbance, set a plurality of overrides to generate a resultant acceleration. The vehicle dynamics influencing controller can determine the allowable propulsion torque modification based on whether the resultant acceleration from the plurality of overrides is greater than a reduction to balance a yaw disturbance.



DETERMINING TORQUE MODIFICATION VIA INTEGRATING VEHICLE DYNAMICS INFLUENCING SUBSYSTEMS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Non-Provisional Application that claims the benefit of U.S. Provisional Patent Application Serial No. 62/217,931, filed on September 13, 2015, the disclosures of which are hereby incorporated by reference herein in their entirety.

FIELD OF THE INVENTION

[0002] Contemporary implementations of ground vehicles include a do-nothing-approach with respect to a vehicle yaw rate. For example, internal systems of these vehicles do not integrate vehicle dynamics influencing subsystems that control and mitigate yaw rates and, in turn, require a driver to react to changes in vehicle handling. Thus, contemporary implementations of ground vehicles do not maximize a performance potential of these vehicles.

BACKGROUND

[0003] Accordingly, it is desirable to determine allowable propulsion torque modification through integration with vehicle dynamics influencing subsystems.

SUMMARY OF THE INVENTION

[0004] In an embodiment, a method by a vehicle dynamics influencing controller of a vehicle to determine an allowable propulsion torque modification is provided. The method includes modifying first and second axle torques based on a vehicle dynamics condition to generate modified first and second axle torques and utilizing the modified first and second axle torques to calculate a maximum request torque modification yaw rate disturbance. Further, the method includes, in accordance with whether a vehicle dynamics allowed yaw rate propulsion target is greater than or equal to maximum request torque modification yaw rate disturbance, setting a plurality of overrides to generate a resultant acceleration. The method also includes determining the allowable propulsion torque modification based on whether the resultant acceleration from the plurality of overrides to is greater than a reduction to balance a yaw rate disturbance. The method may be implemented in a system and/or a computer program product as further described herein.

[0005] The above features and advantages are readily apparent from the following detailed description when taken in connection with the accompanying drawings and claim.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Other features, advantages and details appear, by way of example only, in the following detailed description of embodiments, the detailed description referring to the drawings in which:

[0007] FIG. 1 depicts a schematic plan view of a vehicle according to an embodiment;

[0008] FIG. 2 depicts another schematic plan view of a vehicle according to an embodiment;

[0009] FIG. 3 depicts a processing system of a vehicle according to an embodiment; and

[0010] FIG. 4 depicts a process flow schematic for determining an allowable propulsion torque modification according to an embodiment.

DESCRIPTION OF THE EMBODIMENTS

[0011] The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

[0012] In accordance with an embodiment, FIG. 1 illustrates a vehicle 20 having a differential assembly 22. The differential assembly 22 may sometimes be referred to as a rear drive module. It should be appreciated that the vehicle 20 may be, for example, an automobile, a truck, a van or a sport utility vehicle. As used herein, the term vehicle is not limited to just an automobile, a truck, a van or a sport utility vehicle, but may also include any self-propelled or towed conveyance suitable for transporting a burden. The vehicle 20 may include an engine 24. The engine 24, for example, may be a gasoline or diesel fueled internal combustion engine or may be a hybrid type engine that combines an internal combustion engine with an electric motor or be a fully electric engine. The engine 24 and differential assembly 22 are coupled to a frame or other chassis structure 26. The engine 24 is coupled to the differential assembly 22 by a transmission 28 and a driveshaft 30. The transmission 28 may be configured to reduce the rotational velocity and increase a torque of

an engine output. This modified output is then transmitted to the differential assembly 22 via the driveshaft 30. The differential assembly 22 transmits the output torque from the driveshaft 30 through a differential gear set 32 to a pair of driven-wheels 34 via axles 36.

[0013] The differential gear set 32 is arranged within a differential housing 42. The differential gear set 32 receives the output from the driveshaft 30 via a pinion gear 40 that transmits the torque to a ring gear 44. The pinion gear 40 includes a shaft that is coupled to the driveshaft 30 by a flange 46. The differential gear set 32 is supported for rotation within the housing 42 by a pair of differential bearings. The differential gear set 32 includes side gears 38 arranged within the housing 42 that are coupled to and support one end of the axles 36. The coupling of rotational components, such as the flange 46 to the pinion gear 40 or the side gears 38 to the axles 36 for example, may be accomplished using a spline connection. Note that the differential assembly 22 in an embodiment can be an electronically controlled limited-slip differential (type of automotive differential gear arrangement that allows for some difference in angular velocity, but imposes a mechanical limit on the disparity).

[0014] In an embodiment, each axle 36 extends into an axle tube 54. The axle tube 54 includes a hollow interior that extends the length thereof. At one end of the axle tube 54 a bearing 56 is mounted to support the end of the axle 36 adjacent the driven-wheel 34. A shaft seal 57 is located between the bearing 56 and the driven-wheel 34. A brake assembly 58 is coupled to the end of the axle 36 adjacent the bearing 56. The brake assembly 58 is configured to selectively slow the rotation of the wheel 34 in response to an action by the operator, such as applying the brake pedal or activating the parking brake. The brake assembly 58 may be any known braking system used with vehicles, such as a caliper/rotor assembly. In an embodiment, the brake assembly 58 can be connected to a hydraulic circuit that is driven by a hydraulic system 59. The hydraulic system 59 may include a booster device that increases the amount of hydraulic force that is applied to the brakes 58, 61. The hydraulic system 59 may be driven by the engine 24 or electrically driven by a separate electrical motor (not shown). Note that in other embodiments the brake assembly 58 may include other systems in combination with (or rather than) the hydraulic system 39.

[0015] The brake assembly 58 is also configured to function as a parking brake. In an embodiment, the brake assembly includes an electronic parking brake system 69 having an electrical motor 63 that is coupled to a brake caliper. When a parking brake is activated by the operator (such as with a button or lever 65) the motors 63 actuate to engage the calipers

with the rotor. The electronic parking brake system 69 and the actuator 65 can be coupled to a controller 67.

[0016] The vehicle 20 further includes a second set of wheels 60 arranged adjacent the engine 24. In an embodiment, the second set of wheels 60 is also configured to receive output from the engine 24. This is sometimes referred to as a four-wheel or an all-wheel drive configuration. In this embodiment, the vehicle 20 may include a transfer case 62 that divides the output from the transmission 28 between the front and rear driven wheels 34, 60. The transfer case 62 transmits a portion of the output to a front differential assembly 64, which may include additional components such as a differential gear set 66 and axles 68 that transmit the output to the wheels 60. In another embodiment, the transfer case 62 can be omitted from the vehicle and the axles 68 may be de-coupled. Similar to the rear wheels 34, the front wheels 60 include brakes 61. The brakes 61 are configured to selectively slow the rotation of the front wheels 60 in response to an action by the operator. In an embodiment, the brakes 61 are also coupled to and actuated by the hydraulic system 59. In an embodiment, the system 59 is configured to selectively isolate the front brakes 61 and the rear brakes 58.

[0017] The vehicle 20 further includes a yaw rate control system 80 (e.g., a vehicle dynamics influencing subsystem) that can measure and/or control a yaw rotation of the vehicle 20. A yaw rotation is a movement around a yaw axis of the vehicle 20 that changes a pointing direction of the vehicle 20, to a left or right of a direction of motion of the vehicle 20. The yaw rate of the vehicle 20 is an angular velocity of this rotation (or rate of change of a heading angle). Thus, the yaw rate control system 80, in an embodiment, maintains/controls the yaw rate and variation thereof of the vehicle 20 according to input values, such as measurements from yaw rate sensors (or from any sensors of any system or subsystem throughout the vehicle 20).

[0018] Yaw rate sensors (not shown) of the yaw rate control system 80 can be utilized to determine the yaw rate of the vehicle 20 in degrees per second or radians per second. Examples of a yaw rate sensor include accelerometers, gyroscopes, etc. The yaw rate can be measured by the ground velocity at two geometrically separated points on the vehicle 20 by or synthesized from accelerometers (e.g., the yaw rate can be measured with accelerometers in a vertical axis). In this way, the yaw rate control system 80 can utilize yaw rate sensors to measure an angular velocity of the vehicle 20 around the vertical axis (or z-axis) of the vehicle 20. The yaw rate is directly related to a lateral acceleration of the vehicle 20 turning

at constant or varying speed around a constant or varying radius. Note that an angle between a heading of the vehicle 20 and an actual movement direction of the vehicle 20 is a slip angle, which is related to the yaw rate.

[0019] The yaw rate can be controlled through actuators (not shown). In general, an actuator is any motor type responsible for moving or controlling a mechanism or system of the vehicle 20. Examples of actuators include by are not limited to hydraulic actuators, pneumatic actuators, electric actuators, thermal actuators, magnetic actuators, and mechanical actuators (e.g., vehicle dynamics influencing actuators, such as a front propulsion actuator, a rear propulsion actuator, a torque vectoring differential, an active steering system, etc.). These actuators can be integrated into the yaw rate control system 80, integrated into another vehicle dynamics influencing system of the vehicle 20, or be any actuator of any system or subsystem throughout the vehicle 20. In this way, the yaw rate control system 80 (or other controller of the vehicle 20) can, based on the measurements/inputs from sensors, as noted above, and calculations performed by the yaw rate control system 80, control actuators to apply forces to the vehicle 20. Note that the vehicle 20 may not have to specifically rely on the actuators of the yaw rate control system 80 to maintain stability, as distribution of mass may also be accounted for and utilized by the yaw rate control system 80 when performing the calculations.

[0020] Referring now to FIG. 2, another type of vehicle 20 is shown. In this embodiment, the vehicle 20 includes a rear drive system 100 that uses electrical power from a battery system 102 (e.g., a cell pack) to provide drive torque to the rear wheels 34. The rear drive system 100 includes electrical motors that are coupled to the rear axles 36 to transfer torque to the rear wheels 34. The battery system 102 is connected to the rear drive system 100 via a power controller 104. A charging system 106 (e.g. an alternator or generator) may be connected between the engine 24 and the power controller 104 to provide electrical power for replenishing the battery system 102. It should be appreciated that the vehicle 20 can be any combination or variation of a motor drive, an electric engine, and/or internal combustion engine (front or rear, coupled or decoupled propulsion system; Note that coupled includes a 'mechanically connected' system, while decoupled include 'mechanically separate'), e.g., the mechanical flywheel kinetic energy storage device that could be creating the regenerative or propulsion disturbance. It should also be appreciated that the yaw rate control system 80 described herein may be used with any type of vehicle, such as the vehicles 20 shown in FIG. 1 and FIG. 2.

[0021] In accordance with an embodiment, as a yaw rate of the vehicle 20 varies, the controller 67 may utilize the yaw rate control system 80 to maintain the yaw rate of the vehicle 80. For example, the controller 67 can be configured to operate actuators of the yaw rate control system 80 in response to measurements of the yaw rate sensors, as the vehicle 20 is operated. In this way, it should be appreciated that any operation of the yaw rate control system 80 can be adjusted based on operational characteristics of the vehicle 20. For instance, when the vehicle 20 is turning at a faster speed, the controller 67 may operate and control the actuators of the yaw rate control system 80 to cause the actuators to apply an increased amount of stabilizing force to portions of the vehicle than if the vehicle 20 is turning at a slower speed. Note that the controller 67 and the yaw rate control system 80 (as well as other systems and subsystems of the vehicle 20) can be separate systems or integrated into a single processing system, such as show in FIG. 3.

[0022] Referring now to FIG. 3, there is shown an embodiment of a processing system 300 for implementing the teachings herein. In this embodiment, the processing system 300 has one or more central processing units (CPU(s)) 301a, 301b, and 301c. (collectively or generically referred to as processor(s) 301). The processors 301, also referred to as processing circuits, are coupled via a system bus 302 to system memory 303 and various other components. The system memory 303 can include read only memory (ROM) 304 and random access memory (RAM) 305. The ROM 304 is coupled to system bus 302 and may include a basic input/output system (BIOS), which controls certain basic functions of the processing system 300. RAM is read-write memory coupled to system bus 302 for use by processors 301.

[0023] FIG. 3 further depicts an input/output (I/O) adapter 306 and a communications adapter 307 coupled to the system bus 302. I/O adapter 306 may be a small computer system interface (SCSI) adapter that communicates with a hard disk 308 and/or tape storage drive 309 or any other similar component. I/O adapter 306, hard disk 308, and tape storage drive 309 are collectively referred to herein as mass storage 310. The software 311 for execution on processing system 300 may be stored in mass storage 310. The mass storage 310 is an example of a tangible storage medium readable by the processors 301, where the software 311 is stored as instructions for execution by the processors 301 to perform a method, such as the embodiment of FIG. 4. The communications adapter 307 interconnects system bus 302 with an outside network 312 enabling processing system 300 to communicate with other such systems. A display 315 (e.g., a screen) is connected to system bus 302 by a display adapter

316, which may include a graphics controller to improve the performance of graphics intensive applications and a video controller. In one embodiment, adapters 306, 307, and 316 may be connected to one or more I/O buses that are connected to system bus 302 via an intermediate bus bridge (not shown). Suitable I/O buses for connecting peripheral devices such as hard disk controllers, network adapters, and graphics adapters typically include common protocols, such as the Peripheral Component Interconnect (PCI). Additional input/output devices are shown as connected to system bus 302 via an interface adapter 320 and the display adapter 316. A keyboard 321, a mouse 322, and/or a speaker 323 can be interconnected to system bus 302 via interface adapter 320, which may include, for example, a Super I/O chip integrating multiple device adapters into a single integrated circuit.

[0024] As configured in FIG. 3, the processing system 300 includes processing capability in the form of processors 301, storage capability including system memory 303 and mass storage 310, input means such as the keyboard 321 and the mouse 322, and output capability including the speaker 323 and the display 315. In an embodiment, a portion of system memory 303 and mass storage 310 collectively store an operating system to coordinate the functions of the various components shown in FIG. 3. The processing system 300 will now be described with reference to FIG. 4.

[0025] FIG. 4 depicts a process flow schematic 400 for determining an allowable propulsion torque modification through integration with the vehicle dynamics influencing subsystem (e.g., the yaw rate control system 80 and/or the processing system 300, also referred to as a vehicle dynamics influencing controller) in a decoupled propulsion system, according to an embodiment. Note that, while the below embodiment discusses the decoupled propulsion system, coupled propulsion systems are also contemplated. In general, the process flow schematic 400 provides a determination of when the acceleration potential has been modified by the required handling balance and allows for additional propulsion torque to be applied and the handling characteristics to be compensated for by other vehicle dynamics influencing subsystems.

[0026] In an embodiment, in a decoupled propulsion architecture, the torque distribution from front to rear can be widely variable. When cornering and accelerating, this torque distribution governs both vehicle acceleration and handling. If torque distribution requires a reduction to maintain a driver's desired handling behavior, there is inherently a reduction in the maximum acceleration potential. The process flow schematic 400 provides a strategy to optimize both handling and acceleration through the use of other vehicle dynamic

sub-systems. Particularly, while an alternative is to not allow integration of vehicle dynamics influencing subsystems and therefore to not realize the maximum performance potential, the process flow 400 provides, with a decoupled propulsion architecture, a determination of how much additional torque modification can be generated from the primary or secondary propulsion actuator (e.g., front or rear propulsion actuators) through integration with other vehicle dynamics influencing subsystems.

[0027] In operation, process flow schematic 400 begins at block 401, where the processing system 300 executes a Processing Heuristic #1 that receives, as an I-1, a clutch status (e.g., from a front axle electric motor). By executing the Processing Heuristic #1, the processing system 300 is determining or selecting one of three strategies.

[0028] One strategy, at block 405, is a graceful transition strategy (e.g., Condition 1). The graceful transition strategy is a determination of what to do when a secondary propulsion mechanism (e.g., the front axle electric motor) is coupled, coupling, decoupled, or decoupling from the axles 36, 68 and/or wheels 34, 60. In this way, Condition 1 is where a change in a clutch status is coming and/or state of a charge is approaching a minimum; therefore, a graceful change is needed in a vehicle dynamic behavior (two-wheel drive ↔ all-wheel drive) via other actuators.

[0029] Another strategy, at block 410, is a no modification strategy (e.g., Condition 2). The no modification strategy is required to utilize an actual front axle request and an actual rear axle torque request (e.g., the processing system 300 of FIG. 3 maintains the status quo and does not provide a yaw disturbance mitigation). In turn, the processing system 300 (FIG. 3) sets a plurality of outputs to zero (e.g., O-1, O-2, and O-3). That is, a rear axle torque override is set to zero (O-1), a front axle torque override is set to zero (O-2), and a propulsion yaw rate disturbance is set to zero (O-3). Note that the process flow schematic 400 can supply at least one of the outputs O-1, O-2, and O-3 to other systems or subsystems of the vehicle 20.

[0030] Another strategy (e.g., Condition 3) is calculating the maximum yaw rate disturbance, as shown in sub-process flow involving block 415 (beginning at block 420 and concluding at block 435). Condition 3, for example, is where the controller (e.g., the vehicle dynamics influencing controller) has a modified torque request for vehicle dynamics that other actuators may be able to mitigate. Note that Condition 3 can focus on acceleration and not torque.

Processing Heuristic #1 of block 401

IF (front axle torque request > actual front axle torque request OR rear axle torque request > actual rear axle torque request AND clutch status = connected)

THEN

IF (track detect = detected OR charge deplete mode selected)

THEN

Condition 3

ELSE

Condition 2

END

ELSE

IF (clutch status = reconnecting or disconnecting OR state of charge < To Be Determined (TBD) %)

THEN

Condition 1

ELSE

Condition 2

END

[0031] Turning to block 420, an accelerator pedal position (e.g., as I-2) is received by a propulsion arbitrating system. The propulsion arbitrating system performs calculations/determination based on the accelerator pedal position outputs (noted below) associated with an accelerometer pedal. These outputs indicate demanded acceleration by the driver, which further indicates an axle request. The propulsion arbitrating system can also receive a clutch status (e.g., connected, disconnected, reconnecting, and disconnecting) and a boosting status (e.g., active or non-active). The propulsion arbitrating system, in turn, generates a plurality of output signals (e.g., signals A-G). These output signals include but are not limited to a maximum rear axle torque capacity (signal A), a maximum rear axle torque capability (Signal B), a maximum front axle torque capacity (signal C), a maximum front axle torque capability (signal D), a driver demanded acceleration (signal E), a rear axle torque request (signal F), and a front axle torque request (signal G).

[0032] The output signals of block 420 are received by a controller, at block 425, where, for a given vehicle dynamics handling decision, the controller is modifying the front and rear axle torques to maintain a target handling. The controller also receives a front axle

torque override (e.g., I-3) and a rear axle torque override (e.g., I-4). Based on these inputs, the controller outputs a set of signals (e.g., signal H-J) to block 430. For example, the controller outputs an actual rear axle torque request (signal H), an actual front axle torque request (signal I), and an actual acceleration (signal J) to a Processing Heuristic #2 of block 430. Note that signals H and I, along with signals F and G, are fed to block 415 to calculate a maximum yaw rate disturbance that will also be used by the Processing Heuristic #2 of block 430.

[0033] Returning to block 415, the rear axle torque request (signal F) and the front axle torque request (signal G) are utilized, along with the actual rear axle torque request (signal H) and the actual front axle torque request (signal I), to calculate the maximum yaw rate distribution. In this way, the processing system 300 (FIG. 3) calculates a maximum request torque modification yaw rate disturbance from a delta between the Signal F and Signal H and a delta between the signal G and signal I. The maximum request torque modification yaw rate disturbance is supplied to the Processing Heuristic #2, while an additional output O-4 (e.g., a front axle yaw rate disturbance) can be supplied to other systems or subsystems of the vehicle 20.

[0034] With the maximum request torque modification yaw rate disturbance determined, the ability of each actuator can now be determined. At block 430, the Processing Heuristic #2 utilizes the signals H-J, along with I-5 (e.g., a vehicle dynamics allowed yaw rate propulsion target), to supply signals K and L (e.g., a rear axle torque override and a front axle torque override) to block 435. In addition, the process flow schematic 400 produces outputs O-5 and O-6 (e.g., an estimated long acceleration change and a propulsion yaw rate disturbance), which can be supplied to other system or subsystems of the vehicle 20.

Processing Heuristic #2 of block 430

IF (vehicle dynamics allowed yaw propulsion target > maximum request torque modification yaw disturbance)

THEN

rear axle torque override = rear axle torque request

AND

front axle torque override = front axle torque request

AND

propulsion yaw disturbance = maximum request torque modification yaw disturbance

AND

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estimated longitudinal acceleration change
ELSE
back calculate change in front axle torque
AND/OR
rear axle torque that will generate a maximum request torque modification yaw
disturbance equal to vehicle dynamics allowed yaw propulsion target
AND
rear axle torque override = vehicle dynamics modified rear axle torque request AND
front axle torque override = vehicle dynamics modified front axle torque request
AND
propulsion yaw disturbance = vehicle dynamics modified yaw disturbance AND
estimated longitudinal acceleration change
END

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[0035] At block 435, a Processing Heuristic #3 is executed by the processing device 300 (FIG. 3) based on the rear axle torque override (signal K) and the front axle torque override (signal L) supplied from block 430, along with an indication of whether an override is allowed (e.g., I-6). With respect to the indication of whether the override is allowed, a check is performed to determine a torque and yaw rate with a level of acceleration. In this way, an actuator that used to balance torque and yaw rate will decrease the balance torque and the yaw rate when the vehicle is accelerating. The Processing Heuristic #3 then provides outputs O-7 and O-8 (e.g., the rear axle torque override and the front axle torque override), which can be supplied to other system or subsystems of the vehicle 20.

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Processing Heuristic #3 of block 435
IF (override not allowed = TRUE)
THEN
rear axle torque override = 0
AND
front axle torque override = 0
ELSE
rear axle torque override = rear axle torque override
AND
front axle torque override = front axle torque override
END

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[0036] Note that the blocks 401, 405, 410, 415, 420, 425, 430 and 435 can be implemented as hardware, software, or combination thereof within the vehicle dynamics influencing subsystem, the yaw rate control system 80, the processing system 300, etc.

[0037] In view of the above, an embodiment can include a method by a vehicle dynamics influencing controller of a vehicle to determine an allowable propulsion torque modification. The method includes modifying first and second axle torques based on a vehicle dynamics condition to generate modified first and second axle torques; utilizing the modified first and second axle torques to calculate a maximum request torque modification yaw rate disturbance; in accordance with whether a vehicle dynamics allowed yaw propulsion target is greater than or equal to maximum request torque modification yaw disturbance, setting a plurality of overrides to generate a resultant acceleration; and determining the allowable propulsion torque modification based on whether the resultant acceleration from the plurality of overrides is greater than a reduction to balance a yaw disturbance.

[0038] The technical effects and benefits of the embodiments herein include allowing for vehicle handling and acceleration performance to be maximized through the integration of propulsion and vehicle dynamics influencing subsystems. The embodiments herein, including the above mentioned processing heuristics, are necessarily rooted in the processing system (e.g., via hardware, software, or combinations thereof) to provide the above technical effects and benefits to overcome problems specifically arising in vehicle control. Embodiments herein include a system, a method, and/or a computer program product.

[0039] The computer program product can include a computer readable storage medium (or media) having computer readable program instructions thereon for causing a processor to carry out aspects of embodiments herein.

[0040] The computer readable storage medium can be a tangible device that can retain and store the computer readable program instructions for use by an instruction execution device (e.g., a processor). The computer readable storage medium can be, for example, but is not limited to, an electronic storage device, a magnetic storage device, an optical storage device, an electromagnetic storage device, a semiconductor storage device, or any suitable combination of the foregoing. A non-exhaustive list of more specific examples of the computer readable storage medium includes the following: a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a static random access memory (SRAM), a portable compact disc read-only memory (CD-ROM), a digital

versatile disk (DVD), a memory stick, a floppy disk, a mechanically encoded device such as punch-cards or raised structures in a groove having instructions recorded thereon, and any suitable combination of the foregoing. A computer readable storage medium, as used herein, is not to be construed as being transitory signals per se, such as radio waves or other freely propagating electromagnetic waves, electromagnetic waves propagating through a waveguide or other transmission media (e.g., light pulses passing through a fiber-optic cable), or electrical signals transmitted through a wire.

[0041] The computer readable program instructions can be assembler instructions, instruction-set-architecture (ISA) instructions, machine instructions, machine dependent instructions, microcode, firmware instructions, state-setting data, or either source code or object code written in any combination of one or more programming languages, including an object oriented programming language such as Smalltalk, C++ or the like, and conventional procedural programming languages, such as the "C" programming language or similar programming languages, for carrying out operations described herein. The computer readable program instructions can execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server.

[0042] The computer readable program instructions can be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the operations/acts specified in the flowchart and/or block diagram block or blocks. The computer readable program instructions can also be stored in a computer readable storage medium that can direct a computer, a programmable data processing apparatus, and/or other devices to operate in a particular manner, such that the computer readable storage medium having instructions stored therein comprises an article of manufacture including instructions which implement aspects of the operation/act specified in the flowchart and/or block diagram block or blocks. In some embodiments, electronic circuitry including, for example, programmable logic circuitry, field-programmable gate arrays (FPGA), or programmable logic arrays (PLA) may execute the computer readable program instructions by utilizing state information of the computer readable program instructions to personalize the electronic circuitry, to perform aspects of embodiments herein. The computer readable program instructions can be downloaded to respective

computing/processing devices from a computer readable storage medium or to an external computer or external storage device via a network.

[0043] The network may comprise copper transmission cables, optical transmission fibers, wireless transmission, routers, firewalls, switches, gateway computers and/or edge servers. Examples of the network include the Internet, a local area network (LAN), a wide area network (WAN), controller area network (CAN), and/or a wireless network. A network adapter card or network interface in each computing/processing device receives computer readable program instructions from the network and forwards the computer readable program instructions for storage in a computer readable storage medium within the respective computing/processing device.

[0044] Aspects described herein are with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems), and computer program products according to embodiments. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer readable program instructions.

[0045] The flowchart and block diagrams in the FIGS. illustrate the architecture, operability, and operation of possible implementations of systems, methods, and computer program products according to various embodiments. Further, each block in the flowchart or block diagrams may represent a module, segment, or portion of instructions, which comprises one or more executable instructions for implementing the specified logical operation(s). In some alternative implementations, the operations noted in the block may occur out of the order noted in the FIGS. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the operability involved. It will also be noted that each block of the block diagrams and/or flowchart illustration, and combinations of blocks in the block diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified operations or acts or carry out combinations of special purpose hardware and computer instructions.

[0046] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features,

integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one more other features, integers, steps, operations, element components, and/or groups thereof.

[0047] While the embodiments have been described, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the embodiments. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the embodiments without departing from the essential scope thereof. Therefore, it is intended that the disclosure not be limited to the particular embodiments disclosed, but that the disclosure will include all embodiments falling within the scope of the application.

CLAIMS:

What is claimed is:

1. A method, by a vehicle dynamics influencing controller of a vehicle, to determine an allowable propulsion torque modification, comprising:
 - modifying, by the vehicle dynamics influencing controller, first and second axle torques based on a vehicle dynamics condition to generate modified first and second axle torques;
 - utilizing, by the vehicle dynamics influencing controller, the modified first and second axle torques to calculate a maximum request torque modification yaw rate disturbance;
 - setting, by the vehicle dynamics influencing controller, a plurality of overrides to generate a resultant acceleration in accordance with whether a vehicle dynamics allowed yaw propulsion target is greater than or equal maximum request torque modification yaw disturbance; and
 - determining, by the vehicle dynamics influencing controller, the allowable propulsion torque modification based on whether the resultant acceleration from the plurality of overrides is greater than a reduction to balance a yaw disturbance.
2. The method of claim 1, further comprising:
 - selecting, by a processing heuristic, a first strategy from a plurality of strategies, wherein the processing heuristic consumes a clutch status to perform the selecting.
3. The method of claim 2, wherein the first strategy is a graceful transition strategy executed in lieu of the modifying of the first and second axle torques, the utilizing of the modified first and second axle torques, the setting of the plurality of overrides, and the determining of the allowable propulsion torque modification.
4. The method of claim 2, wherein the first strategy is a no modification strategy, where the vehicle dynamics influencing controller sets each of the plurality of overrides to zero, executed in lieu of the modifying of the first and second axle torques, the utilizing of the modified first and second axle torques, the setting of the plurality of overrides, and the determining of the allowable propulsion torque modification.
5. The method of claim 1, wherein the plurality of overrides comprises a rear axle torque, a front axle torque override, and a propulsion yaw rate disturbance.
6. The method of claim 1, wherein the maximum request torque modification yaw rate disturbance comprises a delta between a rear axle torque request and actual rear axle

torque request and a delta between a front axle torque request and actual front axle torque request.

7. The method of claim 1, further comprising:

receiving an accelerator pedal position; and

generating a plurality of outputs from the accelerator pedal position.

8. The method of claim 7, wherein the plurality of outputs comprises a plurality of axle torque requests utilized to calculate the maximum request torque modification yaw rate disturbance.

9. The method of claim 8, wherein the plurality of outputs is utilized by the modifying of the first and second axle torques.

10. The method of claim 8, wherein the plurality of outputs comprises a maximum axle torque capacity, a maximum axle torque capability, a driver demanded acceleration, and an axle torque request.

11. A system, comprising a processor and a memory storing program instructions to determine an allowable propulsion torque modification thereon, the program instructions executable by a vehicle dynamics influencing controller of a vehicle to cause the system to perform:

modifying first and second axle torques based on a vehicle dynamics condition to generate modified first and second axle torques;

utilizing the modified first and second axle torques to calculate a maximum request torque modification yaw rate disturbance;

setting a plurality of overrides to generate a resultant acceleration in accordance with whether a vehicle dynamics allowed yaw propulsion target is greater than or equal maximum request torque modification yaw disturbance; and

determining the allowable propulsion torque modification based on whether the resultant acceleration from the plurality of overrides is greater than a reduction to balance a yaw disturbance.

12. The system of claim 11, wherein the program instructions are further executable by the vehicle dynamics influencing controller to cause the system to perform:

selecting, by a processing heuristic, a first strategy from a plurality of strategies, wherein the processing heuristic consumes a clutch status to perform the selecting.

13. The system of claim 12, wherein the first strategy is a graceful transition strategy executed in lieu of the modifying of the first and second axle torques, the utilizing of

the modified first and second axle torques, the setting of the plurality of overrides, and the determining of the allowable propulsion torque modification.

14. The system of claim 12, wherein the first strategy is a no modification strategy, where the vehicle dynamics influencing controller sets each of the plurality of overrides to zero, executed in lieu of the modifying of the first and second axle torques, the utilizing of the modified first and second axle torques, the setting of the plurality of overrides, and the determining of the allowable propulsion torque modification.

15. The system of claim 11, wherein the plurality of overrides comprises a rear axle torque, a front axle torque override, and a propulsion yaw rate disturbance.

16. The system of claim 11, wherein the maximum request torque modification yaw rate disturbance comprises a delta between a rear axle torque request and actual rear axle torque request and a delta between a front axle torque request and actual front axle torque request.

17. The system of claim 11, wherein the program instructions are further executable by the vehicle dynamics influencing controller to cause the system to perform:
receiving an accelerator pedal position; and
generating a plurality of outputs from the accelerator pedal position.

18. The system of claim 17, wherein the plurality of outputs comprises a plurality of axle torque requests utilized to calculate the maximum request torque modification yaw rate disturbance.

19. The system of claim 18, wherein the plurality of outputs is utilized by the modifying of the first and second axle torques.

20. The system of claim 18, wherein the plurality of outputs comprises a maximum axle torque capacity, a maximum axle torque capability, a driver demanded acceleration, and an axle torque request.

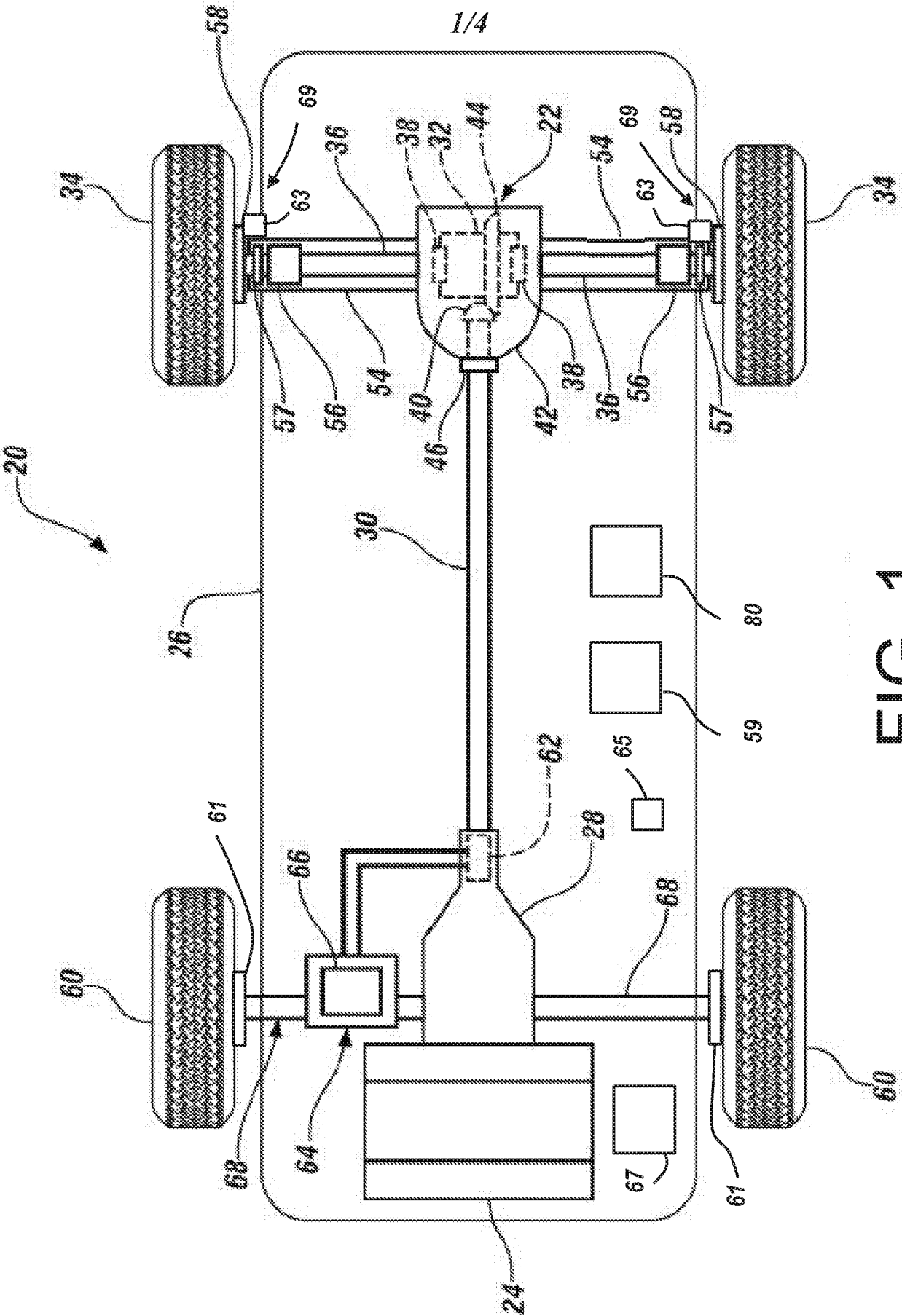


FIG. 1

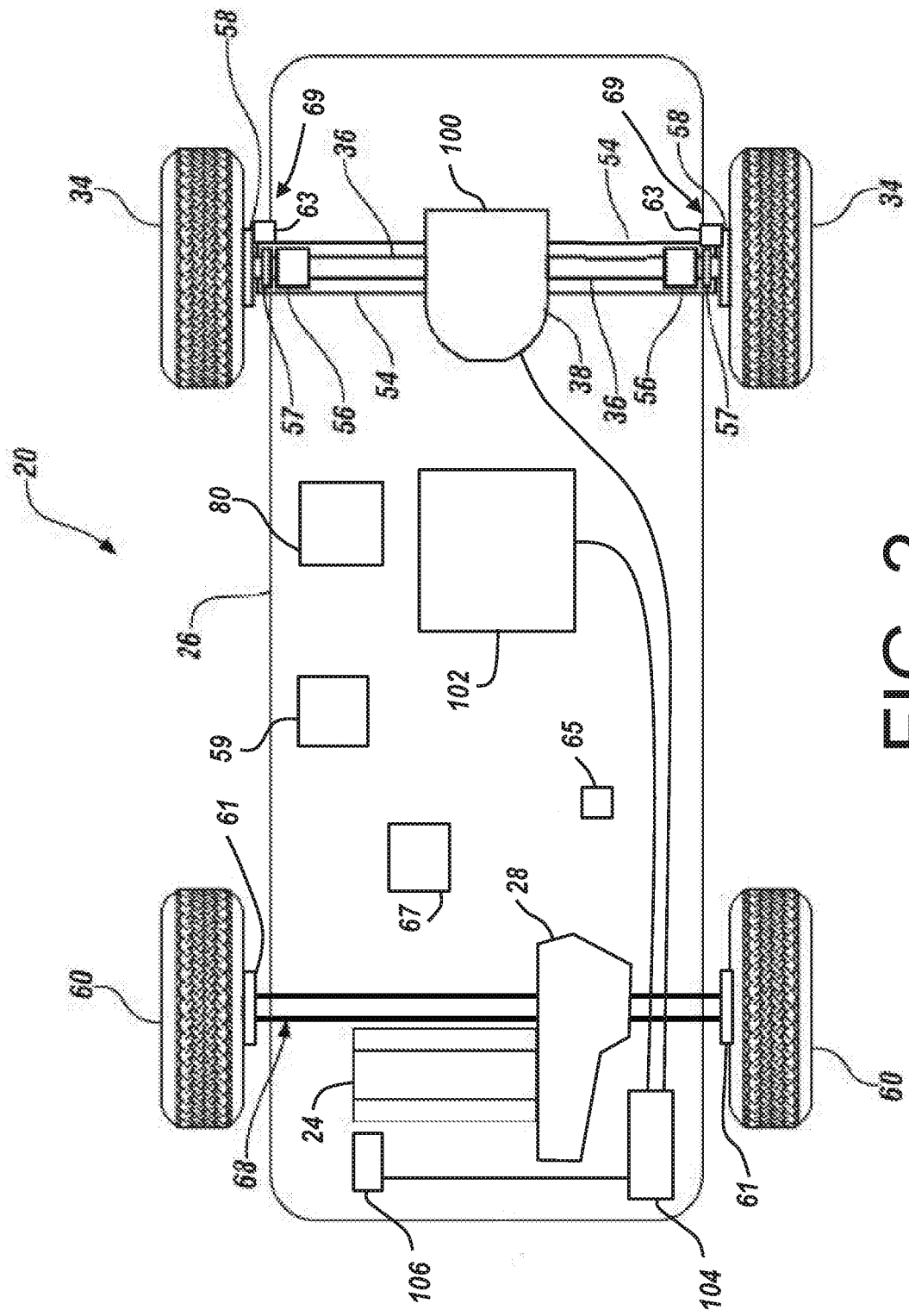


FIG. 2

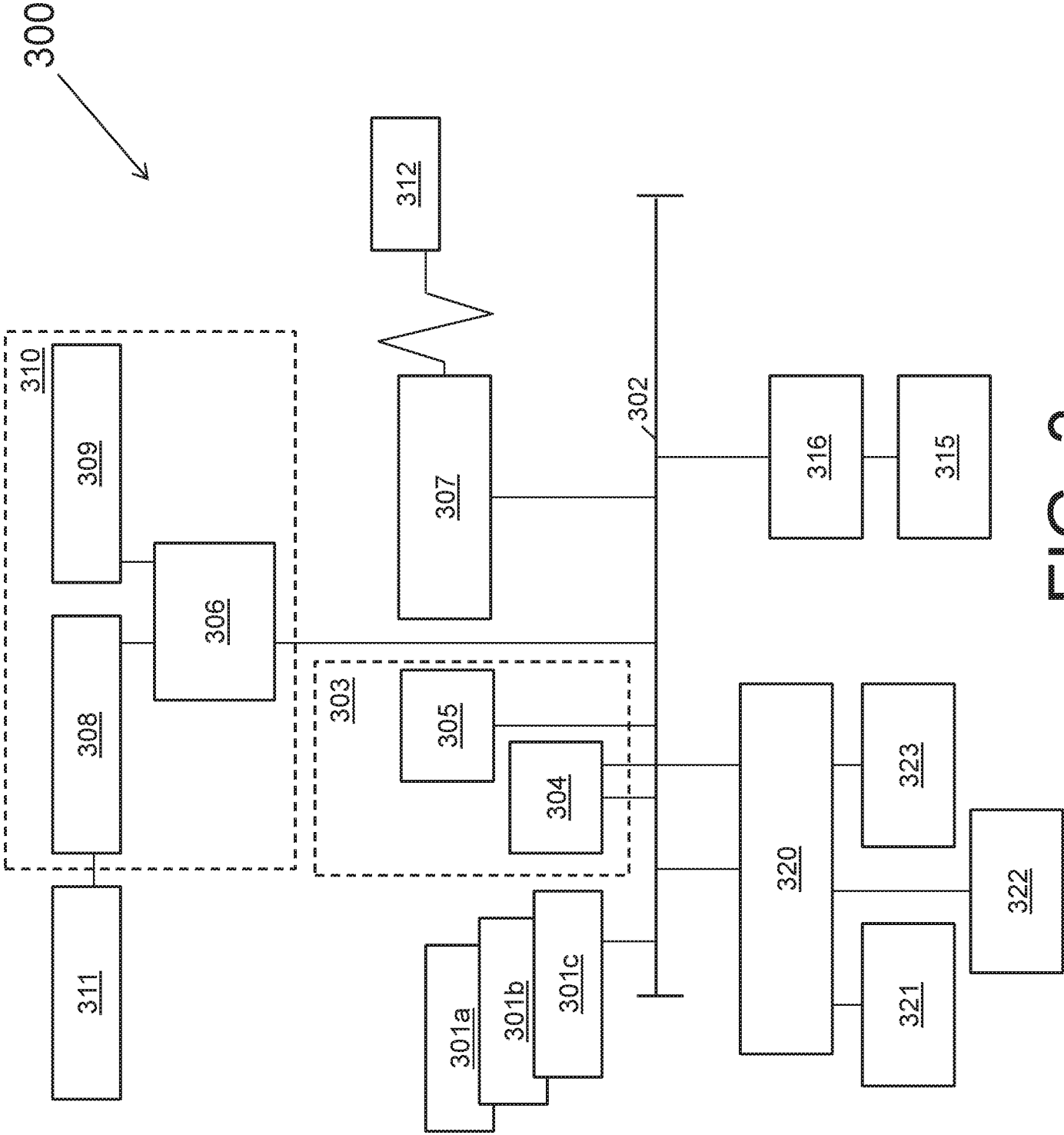


FIG. 3

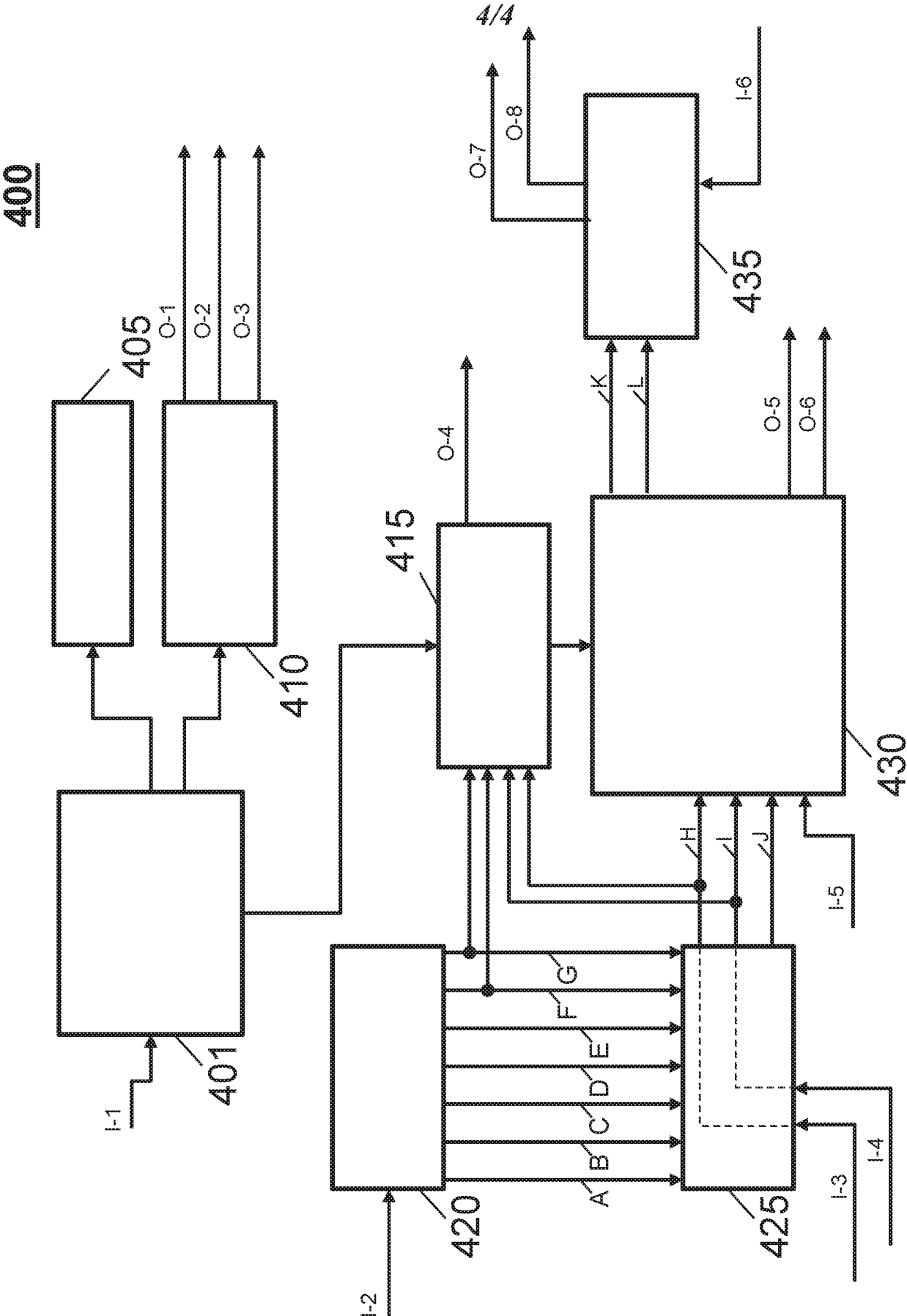


FIG. 4

A. CLASSIFICATION OF SUBJECT MATTER**B60W 10/16(2012.01)i, B60W 40/114(2012.01)i, B60W 10/02(2006.01)i, B60W 50/10(2012.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B60W 10/16; B60T 8/1755; B60W 10/20; G06F 17/00; G06G 7/76; G01G 19/03; B60L 11/00; G01G 19/02; G01P 21/00; B60W 40/114; B60W 10/02; B60W 50/10

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: vehicle, propulsion, torque, modify, axle, yaw

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009-0024263 A1 (SIMON, JR. et al.) 22 January 2009 See paragraphs [0011]-[0014], [0022]-[0025], [0034]-[0036]; and figures 1, 2A.	1-20
Y	US 2013-0013152 A1 (HECKER et al.) 10 January 2013 See paragraphs [0019]-[0026]; and figure.	1-20
A	US 2007-0106443 A1 (LU, JIANBO) 10 May 2007 See paragraphs [0021]-[0049]; and figures 1-2.	1-20
A	US 2009-0089002 A1 (WALTER et al.) 02 April 2009 See paragraphs [0001]-[0013]; and figure 1.	1-20
A	WO 2014-176063 A1 (CATERPILLAR INC.) 30 October 2014 See page 2, line 5 - page 3, line 5; page 4, line 14 - page 11, line 27; and figures 1-6.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search

19 December 2016 (19.12.2016)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/050886

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