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(54) Title: DATA PROCESSING METHOD

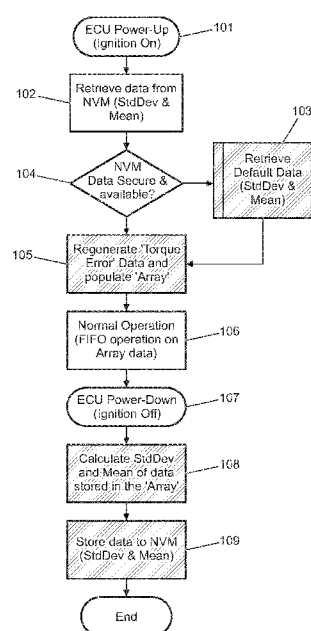


Figure 10

(57) Abstract: A method of processing data, the method comprising: receiving an input from a source of data (24) during operation of the source, storing the data temporarily on a volatile memory (28), determining a distribution function (82) corresponding to the stored data (70) on the volatile memory (28), determining first (84) and second (86) data parameters which define the distribution function (82), storing the first (84) and second (86) data parameters of the distribution function (82) on a non-volatile memory (26), discarding the data from the volatile memory (28) and predicting subsequent data based on the first (84) and second (86) data parameters of the distribution function (82). The method is applicable to a vehicle computer system in which the source of data is a torque error estimator.



Data Processing Method

TECHNICAL FIELD

- 5 The present disclosure relates to a data processing method and particularly, but not exclusively, to a method of processing data in a torque monitoring system on a vehicle. Aspects of the invention relate to a method of processing data, to a torque monitoring module in a vehicle, to a vehicle and to a data processor.

10 BACKGROUND

The automotive functional safety standard ISO 26262 provides a framework for mitigating any unnecessary risks with regards to the malfunctioning behaviour of electric or electronic systems. In complying with this standard, 'hazardous events'
15 associated with the malfunctioning behaviour of the system under consideration are identified.

One example of a safety measure typically employed in automotive control systems is that of a 'software monitoring function'. The purpose of such a monitor is to detect
20 faults within the functional software to which it is assigned and then to cause the system to transition to a safe state should a fault be detected.

It is known in the prior art to use a software monitoring function in an automotive propulsion system. The monitor may be designed to detect faults in the functional
25 software that requests torque from a torque actuator (such as an engine or an electric motor) based on the acceleration that is requested by a driver's requested input. The torque error is periodically calculated during a drive cycle and this data is then stored within an array on the memory of a microprocessor whilst a drive cycle is in progress. The torque error is the difference between the requested torque by a driver demand,
30 and the actual torque generated by the torque actuator. The torque monitoring module calculates a mean torque error from the error data produced by the torque monitoring module which can be used by a vehicle computer system to monitor the error and to reduce the overall error in the system.

Upon start-up of the vehicle the array contains no data indicative of the torque error thus the torque monitoring function calculates an incorrect mean torque error. In order to overcome this it is possible to introduce a delay before calculating the mean torque error in order to allow time for the array to populate. However by doing this the vehicle
5 would be operating in an unprotected state at the start of the drive cycle.

One potential solution to this problem is to store the array on a non-volatile memory (NVM) so that upon power-up of the vehicle, data from the previous cycle is still stored within the array. However, writing and reading large quantities of data to the non-
10 volatile memory is a relatively slow and inefficient process. Also adding non-volatile memory to an Engine Control Unit adds cost and is often constrained due to micro-processor design.

The present invention has been devised to mitigate or overcome at least some of the
15 above-mentioned problems.

SUMMARY OF THE INVENTION

According to an aspect of the present invention there is provided a method of
20 processing data, the method comprising receiving an input from a source of data during operation of the source, storing the data temporarily on a volatile memory, determining a distribution function corresponding to the stored data on the volatile memory, determining first and second data parameters which define the distribution function, storing the first and second data parameters of the distribution function on a
25 non-volatile memory, discarding the data from the volatile memory and predicting subsequent data based on the first and second data parameters of the distribution function.

In one embodiment, the data is discarded from the volatile memory once the operation
30 of the source has been terminated.

In one embodiment of the invention the source of data is a function module on a vehicle. For example, the source of data may be a torque error estimator module running on a vehicle computer system.

This gives the advantage of reducing the requirements put on the non-volatile memory within the vehicle, which in turn allows the Engine Control Unit to run more efficiently. This is because writing and reading large quantities of data to non-volatile memory is a
5 relatively slow and inefficient process, and the present invention avoids the necessity for this.

It will be appreciated that the step of predicting subsequent data and the step of discarding data from volatile memory are interchangeable in sequence, and the order
10 in which these steps take place is not crucial to the invention.

In a further embodiment of the invention the vehicle computer system receives a torque error from the torque error estimator which is a difference between a requested torque by a driver demand and an actual torque generated by a torque actuator. This
15 allows the vehicle computer system to monitor the error in the torque produced by the torque actuator and then make any necessary adjustments in order to reduce the error so that the driver demand substantially corresponds to the actual torque generated.

In one embodiment, upon power-up of the vehicle computer system, predicted data
20 satisfying a distribution function defined by the first and second data parameters is stored on the volatile memory (as opposed to the first and second data parameters which are stored on the non-volatile memory). In this embodiment, the predicted data may be a torque error, as herein defined.

25 By way of example, prior to powering down the vehicle computer system, the first and second data parameters of the distribution function are stored on the non-volatile memory.

In one embodiment of the invention, default first and second data parameters are
30 stored on the non-volatile memory. During a phase of vehicle operation for which no first and second data parameters are available, data is predicted based on the distribution function defined by the default first and second data parameters.

According to one embodiment of the invention the phase of operation for which no first and second data parameters are available includes an initial vehicle use phase (e.g. when the vehicle leaves the manufacturing facility).

- 5 In one embodiment of the invention the phase of operation for which no first and second data parameters are available includes a phase following corruption of data stored on the non-volatile memory. This allows the efficient data storage and retrieval method to work when no data parameters are available, for example, upon an initial power up or if the non-volatile memory is corrupt.

10

- According to another aspect of the invention there is provided a data processor comprising of an input for receiving data from a source during operation of the source, a volatile memory configured to store the data temporarily, a module configured to determine a distribution function corresponding to the stored data and to determine
15 first and second data parameters which define the distribution function, a non-volatile memory configured to store the first and second data parameters of the distribution function and a predictive module configured to predict subsequent data based on the first and second data parameters of the distribution function.

- 20 Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or
25 combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

30 BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic of a vehicle comprising an engine control unit;

Figure 2 shows a block diagram of a torque monitoring module and memory modules within the engine control unit shown in Figure 1;

5

Figure 3 shows a schematic of an example monitor used within a monitoring function;

Figure 4 shows a data array with the data locations marked by an array index;

10 Figure 5 shows the array in Figure 4 filled with data from the torque monitoring module shown in Figure 3;

Figure 6 is a graphical representation of torque error of the type which may be stored in an array in Figure 5.

15

Figure 7 shows a histogram of the torque error data displayed graphically in Figure 6;

Figure 8 shows the histogram in Figure 7 with an overlaid distribution function;

20 Figure 9 shows the distribution function in Figure 8 overlaid on a randomly generated set of data; and

Figure 10 is a flow diagram to illustrate the steps of the data processing method of an embodiment of the invention, utilising the data in Figures 6 to 9.

25

DETAILED DESCRIPTION

A specific embodiment of the invention will now be described in which numerous specific features will be discussed in detail in order to provide a thorough
30 understanding of the inventive concept as defined in the claims. However, it will be apparent to the skilled person that the invention may be put in to effect without the specific details and that in some instances, well known methods, techniques and structures have not been described in detail in order not to obscure the invention unnecessarily.

In order to place the embodiments of the invention in a suitable context, reference will firstly be made to Figure 1. Figure 1 shows a vehicle 12, for example a car, which comprises of an Engine Control Unit (ECU) 10, a torque actuator (not shown) and an accelerator pedal (not shown). The torque actuator is often, but not exclusively, in the form of an electric motor or internal combustion engine. The Engine Control Unit 10 is also known as the vehicle computer system or vehicle control unit (VCU).

The ECU 10, as shown in Figure 2 comprises a torque monitoring module 24, a volatile memory module 28 and a non-volatile memory module 26. The volatile memory module 28 is typically in the form of Random Access Memory (RAM). Due to the nature of volatile memory any data stored on the volatile memory module 28 is lost when the ECU 10 is powered down. The non-volatile memory module 26 is typically a hard drive or flash memory that can store data even when the ECU 10 is powered down. Non-volatile memory is often limited in vehicle computer systems and reading and writing large quantities of data can be a relatively slow process.

An example of a torque monitoring module 24 is shown in Figure 2. The torque monitoring module 24 is an adaptive safety monitoring function within the ECU 10 that monitors the error in the torque produced by the torque actuator when compared to the torque requested by a driver. In general, the error in the torque is calculated by finding the difference between the torque generated by the torque actuator and the value of torque requested by the driver. If the difference between these two values is greater than a pre-determined threshold then the torque monitoring module 24 will enable action to be taken to reduce the error in the torque. This acts as a safety function and ensures that the torque produced by the torque actuator closely matches or corresponds to the torque requested by a driver.

Referring to Figure 3, the torque monitoring module 24 receives an input of the driver-demanded acceleration from the pedal 30. The output 34 from the pedal is also provided to functional software for determining the demanded torque. Within the torque monitoring module 24, an expected torque request 34 is calculated based on the input 30. In addition, a demanded torque input (actual torque request) received from the functional software 32 is provided to a module 36. The difference between the

expected torque request and the actual torque request is calculated in an additional module 38 and is output from the torque monitoring system 24 as a torque error value.

5 The torque monitoring module 24 calculates the torque error on a continual basis during a drive cycle, typically every 20ms. This can result in thousands of discrete data points being stored on the memory module of the vehicle 12. A drive cycle is a term used to describe a phase of operation of a vehicle 12 that includes the powering up, the operation and the powering down of a vehicle 12.

10 In more sophisticated embodiments of the torque monitoring module 24 the mean torque error during a drive cycle is monitored to provide a more accurate representation of the torque error over time. The mean torque error is then used to correct any errors in the expected torque request 34, as described previously. Comparing the expected torque request, which is corrected by the mean torque error, 15 with the actual torque request provides a more robust torque monitoring module 24 and prevents the torque monitoring module 24 from taking unnecessary action for a single rogue data point that falls out with the error threshold.

Figure 4 shows a data array, the like of which could be used to store data produced by 20 the torque monitoring module 24 in Figure 3. The array 40 may have, for example, over a thousand data storage locations for storing data indicative of the torque error although only a few data locations are shown here. The array 40 is stored on the volatile memory module 28 within the ECU 10. Each location within the array 40 is allocated an address, typically in the form of a number. This number is called the Array 25 Index 41. In the embodiment outlined in Figure 4, the array 40 has ten locations and each location is assigned a number which corresponds to the Array Index 41, which in this example is a number between zero and nine. In other embodiments the Array Index 41 could, for example, start at one and end at ten.

30 Figure 5 shows an array 40 populated with error data 52 generated by the torque monitoring module 24. As the torque monitoring module 24 generates data 52, each data point is stored in a location within the array 40. The first calculation of torque error would be stored in the first position of the array 40. The next calculation of torque error will then be stored in the adjacent position of the array 40. This process continues until

the entire array 40 is populated with data points, at which point the cycle begins again by over writing the data 52 in the first position of the array 40 with the latest torque error data point. This process is typically called 'First In First Out' (FIFO) data recordal.

- 5 The data 52 stored within the array 40 is used to calculate a mean torque error which can then be used by the vehicle computer system 10 to correct the error or shut the vehicle 12 down should the error in torque reach an unsafe level. However, because the array 40 is stored on the volatile memory module 28 when the vehicle 12 is powered down the data within the array 40 is lost or discarded. In a prior art system,
10 this results in the array 40 being data-free upon powering up again and thus there is no data available for the torque monitoring module 24 to use to calculate a mean torque error. It is this problem that the present invention addresses.

- Figure 6 is a graph of one hundred torque error data points 60, the like of which could
15 be stored within an array 40 such as that in Figure 4. The graph 60 represents the torque error points with respect to the location they are stored within an array, also known as the Array Index 41. The torque error data shown in Figure 6 is typical of data gathered by the torque monitoring module 24. It shows how there is no real obvious trend between adjacent data points within the array 40. This illustrates the problem of
20 using raw data points, as described above, so that instead a mean torque error will be calculated from the data points to provide a more accurate regulation of the error.

- This data can be represented within a histogram 70 as shown in Figure 7. By representing this data as a histogram 70 it can be seen that the data approximately
25 follows a normal distribution. This is not immediately obvious from the data shown graphically in Figure 6. However, by displaying the information as a histogram this becomes much more apparent. Figure 8 shows the histogram 70 with an overlaid distribution curve 82. The distribution curve 82 is also known as a distribution function 82. The distribution function 82 is calculated by the engine control unit 10 and the characteristics of the function 82 are continuously updated as the data within the array
30 40 is updated. In this example the data set follows a normal distribution but any appropriate distribution function 82 could be applied as calculated by the torque monitoring module 24.

The distribution 82 in Figure 8 contains two data parameters that describe the distribution fully. The first data parameter 84 is the 'mean' of the distribution and the second data parameter 86 is the 'standard deviation' of the distribution 82. The first 84 and second 86 data parameters are stored within the non-volatile memory module 26 within the Engine Control Unit 10. The first 84 and second 86 data parameters can either be written directly to the non-volatile memory 26 or in certain embodiments they can be stored on the volatile memory 28 until the Engine Control Unit 10 is powered down, at which point they are written to the non-volatile memory 26 in order to prevent the data being lost. The raw data stored within the array 40 however is not written to the non-volatile memory 26 and as a result the raw data is lost upon powering down of the vehicle 12.

In general terms, at the start of a drive cycle the array 40 is empty and as a result the torque monitoring module 24 cannot calculate an accurate mean torque error. In order to overcome this issue the torque monitoring module 24 retrieves the first 84 and second 86 data parameters from the non-volatile memory 26, as stored from the previous drive cycle. The torque monitoring module 24 uses the first 84 and second 86 data parameters to recreate a random data distribution 90 that contains the same essential properties of the originating distribution 70. An example of this is shown in Figure 9. Whilst this is not an identical replica of the original distribution 70 shown in Figure 8, it is of sufficient accuracy to support the calculation of a 'mean torque error' and the operation of the torque monitoring module 24 at the beginning of a drive cycle. The mean of the regenerated random data 90 is slightly changed from the original data, but not sufficient to cause concern. Upon start-up, the torque monitoring module 24 only considers the mean torque error and as a result the raw data points are not of importance to the torque monitoring module 24.

Following the generation of the random data 90, the torque monitoring module 24 uses the First in First Out method to overwrite the randomly generated data 90. As the drive cycle progresses the torque monitoring module 24 also updates the first and second data parameters of the distribution function 82.

A more specific description of the processing of the data will now be described with reference to Figure 10 which shows the flow of processes within the Engine Control

Unit 10 when a vehicle 12 is powered up, operated and then powered down. At step 101, the ECU 10 is powered up at the start of a drive cycle. At this stage the data storage array on the volatile memory 28 contains no data from the torque monitoring module 24 because any data from previous drive cycles has been deleted. At step 5 102, the torque monitoring module 24 retrieves data 102 from the non-volatile memory unit 26; typically the data is the first 84 and second 86 data parameters although in certain embodiments of the invention there may be more than two required data parameters.

10 Once the torque monitoring module 24 has successfully retrieved the first 84 and second 86 data parameters from the non-volatile memory 26, at step 105 the torque monitoring module 24 uses the data parameters to generate or 'predict' torque error data. In addition the generated torque error data is used to fully populate the array 40 on the volatile memory unit 28. Data is generated by fitting to a distribution defined by 15 the first 84 and second 86 data parameters and the array 40 is populated on a random basis so that any torque error data value may be assigned to any location in the array.

Prior to generating the torque error data based on first and second data parameters in step 105, in step 104 the torque monitoring module 24 will check to confirm that the 20 first 84 and second 86 data parameters are available. During certain phases of operation the torque monitoring module 24 may be unable to retrieve first 84 and second 86 data parameters. This could be for example due the non-volatile memory unit 26 being corrupt or upon an initial (i.e. very first) vehicle power up when there are no data parameters from any previous drive cycle available. In this situation, the 25 process diverts to step 103 in which the torque monitoring module 24 instead retrieves default data parameters 103 from the non-volatile memory 26 which have been pre-stored in the ECU 10 at the time of vehicle manufacture.

The default data parameters of the distribution function 82 are values based on 30 nominal operation of the vehicle 12 and are generated during a vehicle's development, based upon a statistical representation of several vehicles and modes. The default data parameters are stored within the torque monitoring module 24 and are only used during the aforementioned phases of operation.

After step 105, following an initial power-up phase, once the array 40 has been fully populated with random data values corresponding to the distribution defined by the first 84 and second 86 data parameters, the torque monitoring module 24 reverts to a normal phase of operation at step 106, using actual measured torque error values to
5 populate the array 40. The torque monitoring module 24 populates the array 40 using the First In First Out method as the drive cycle progresses and new data indicative of the torque error is generated and is re-written over the predicted torque error values.

At step 107, at the end of vehicle operation (ignition off), the ECU 10 is powered down.
10 When the vehicle 12 is powered down any data stored on the volatile memory module 28 will be lost. Prior to powering down the vehicle 12, the first and second 84, 86 data parameters are therefore calculated based on the data stored within the array 40 on the volatile memory module 28. The calculated data parameters (standard deviation of the data and the mean of the data) are written to the non-volatile memory module 26 at
15 step 108. The standard deviation and the mean of the data are stored to the non-volatile memory module 26 at step 109 so they can be used in the following drive cycle once the vehicle is re-started again.

The step of calculating the first and second data parameters 84, 86 are carried out on
20 a receipt of a trigger to indicate that the ECU is about to be powered down. Once the calculation is complete, the powering down steps are implemented to shut down the ECU. In other words, the calculation of the data parameters is carried out immediately prior to the ECU being shut down.

25 In more sophisticated embodiments the calculated distribution function 82 may require more than two data parameters to define the distribution fully. In such embodiments all of the required data parameters are written to the non-volatile memory unit 26, and are stored when the vehicle 12 is powered down, so that they are available upon vehicle 12 re-start.

30

The torque monitoring module 24 only reads from the non-volatile memory module 26 at power up of the vehicle 12 and only writes to the non-volatile memory module 26 at powering down of the vehicle 12 (steps 108 and 109). This greatly reduces the requirements of the non-volatile memory module 26, both in terms of the capacity of

the memory module and the requirements of reading and writing large quantities of data very quickly.

Many modifications may be made to the above examples without departing from the
5 scope of the present invention as defined in the accompanying claims.

CLAIMS

1. A method of processing data, the method comprising:
 - 5 receiving an input from a source of data during operation of the source;
 - storing the data temporarily on a volatile memory;
 - 10 determining a distribution function corresponding to the stored data on the volatile memory;
 - determining first and second data parameters which define the distribution function;
 - 15 storing the first and second data parameters of the distribution function on a non-volatile memory;
 - discarding the data from the volatile memory; and
 - 20 predicting subsequent data based on the first and second data parameters of the distribution function.
2. A method as claimed in claim 1, wherein the source of data is a function on a vehicle.
- 25 3. A method as claimed in claim 2, wherein the source of data is a torque monitoring module running on a vehicle computer system.
4. A method as claimed in claim 3, comprising, during a power-up phase of
30 the vehicle computer system,
 - determining predicted data that satisfies a distribution function having the first and second data parameters as stored on the non-volatile memory;

wherein the predicted data is a torque error.

- 5
5. A method as claimed in claim 4, comprising, following the power-up phase of the vehicle computer system, receiving a torque error from the torque monitoring module which is a difference between a requested torque by a driver demand and an actual torque generated by a torque actuator.
- 10
6. A method as claimed in any of claims 2 to 5, comprising, prior to a power-down phase of the vehicle computer system, storing the first and second data parameters of the distribution function on the non-volatile memory.
- 15
7. A method as claimed in any of claims 2 to 6, comprising;
- storing default first and second data parameters on the non-volatile memory, and
- during a default phase of vehicle operation for which no first and second data parameters are available, predicting data based on a distribution function defined by default first and second data parameters.
- 20
8. A method as claimed in claim 7, wherein the default phase of operation for which no first and second data parameters are available includes an initial vehicle use phase.
- 25
9. A method as claimed in claim 7 or claim 8, wherein the default phase of operation for which no first and second data parameters are available includes a phase following corruption of data stored on the non-volatile memory.
- 30
10. A method as claimed in any of claims 1 to 9, wherein the distribution function is a normal distribution function.
- 35
11. A data processor comprising:
- an input for receiving data from a source during operation of the source;

a volatile memory for-storing the data temporarily;

a module for determining a distribution function corresponding to the stored data;

5

a module for determining first and second data parameters which define the distribution function;

10

a non-volatile memory for storing the first and second data parameters of the distribution function; and

a predictive module configured to predict subsequent data based on the first and second data parameters of the distribution function.

15

12. A torque monitoring module for a vehicle comprising the data processor as claimed in claim 11, wherein the predictive module is configured to predict torque error data based on the first and second data parameters of the distribution function.

20

13. A vehicle comprising the torque monitoring module as claimed in claim 12.

14. A method, a data processor, a torque monitoring module and a vehicle substantially as herein described with reference to the accompanying drawings.

25

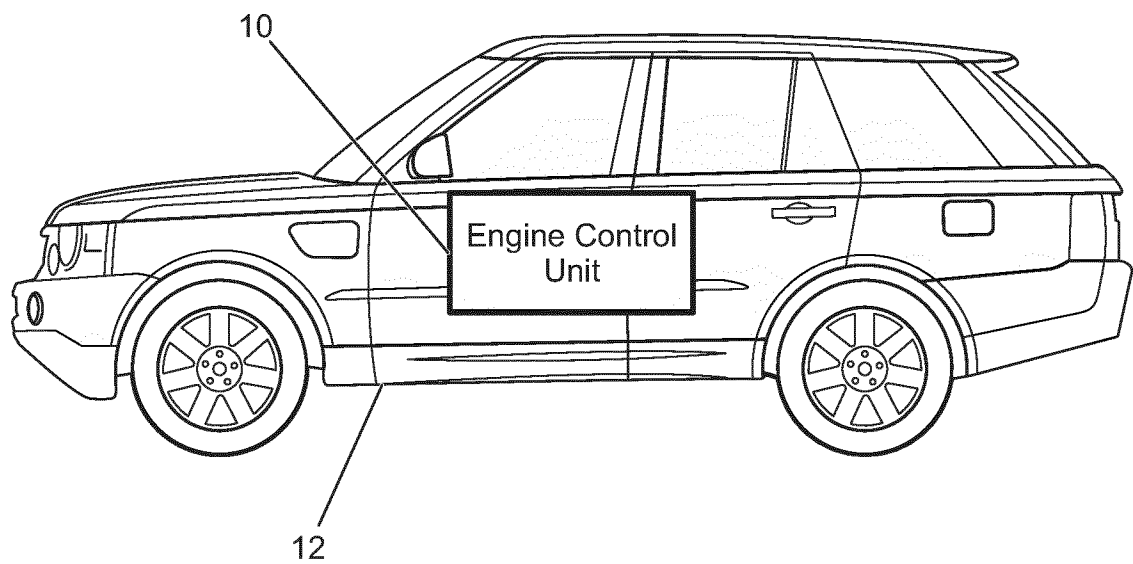


Figure 1

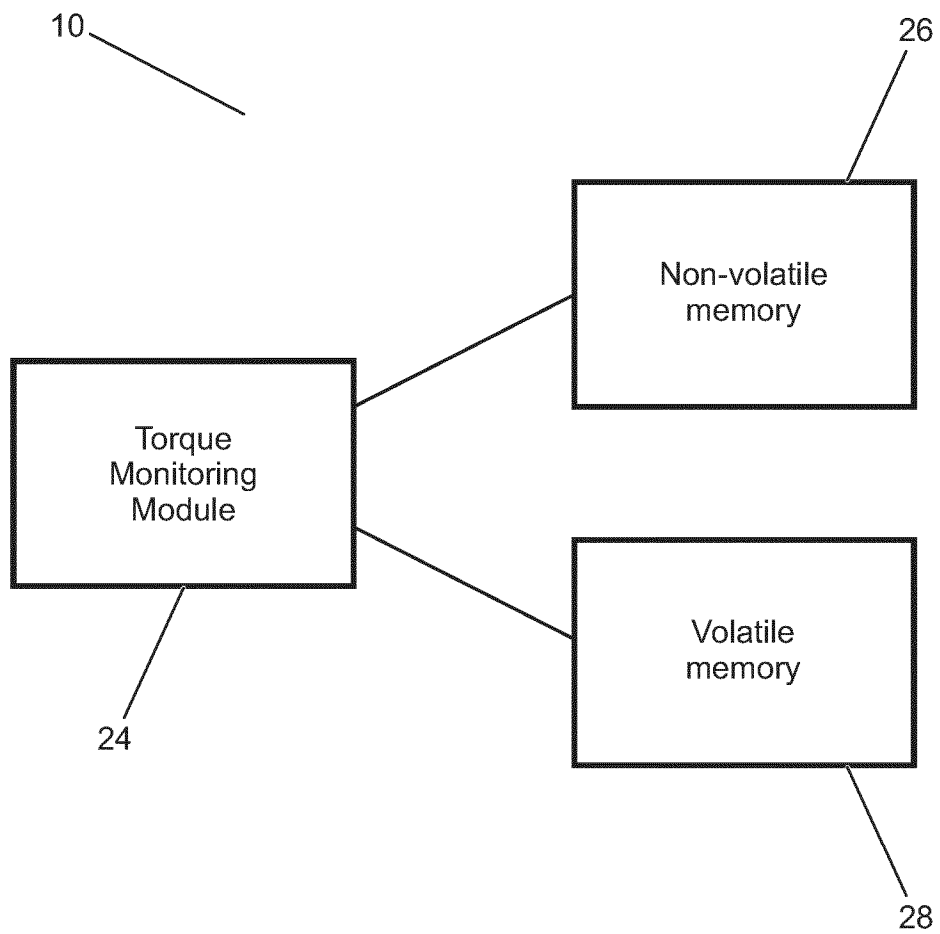


Figure 2

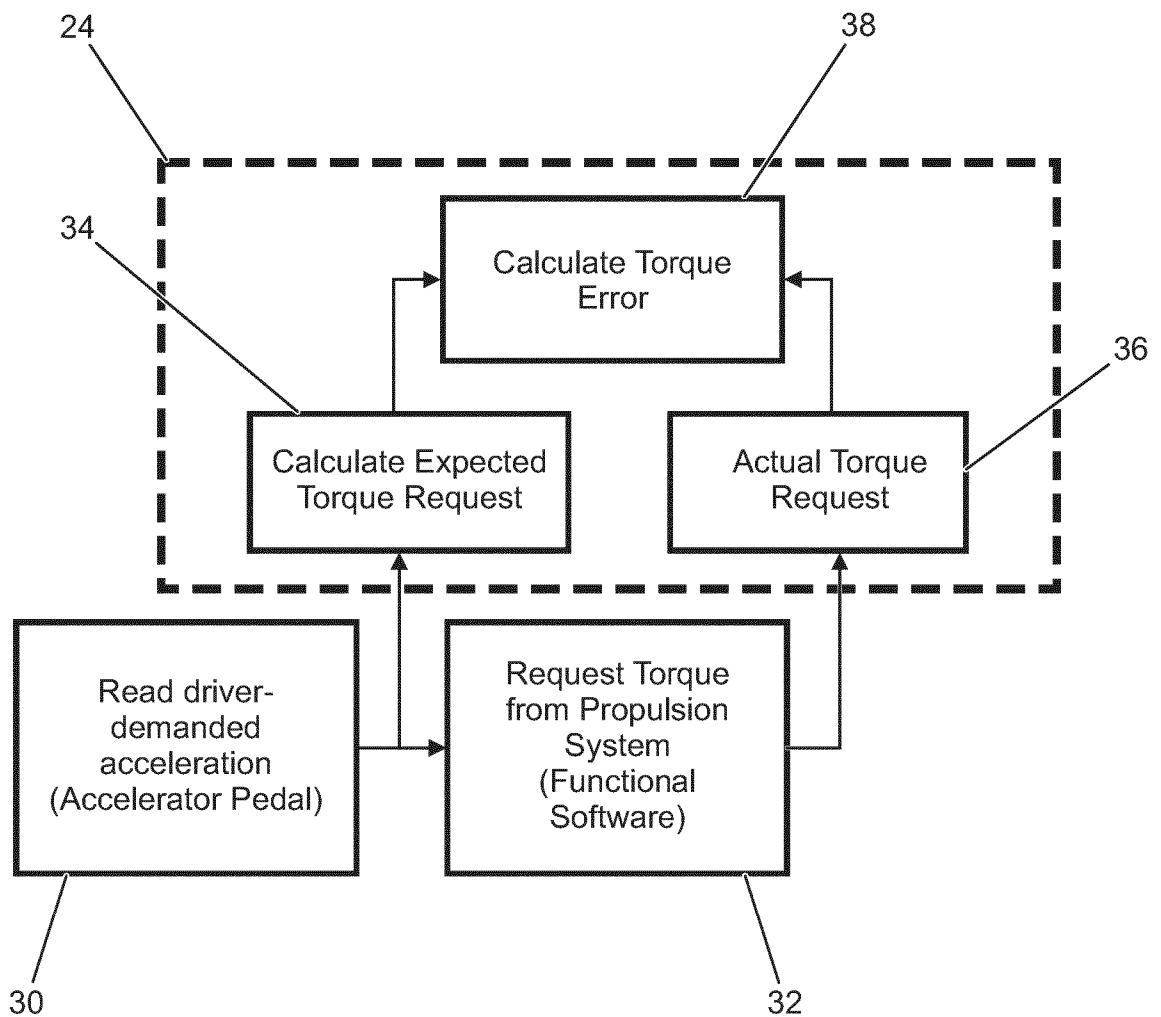


Figure 3

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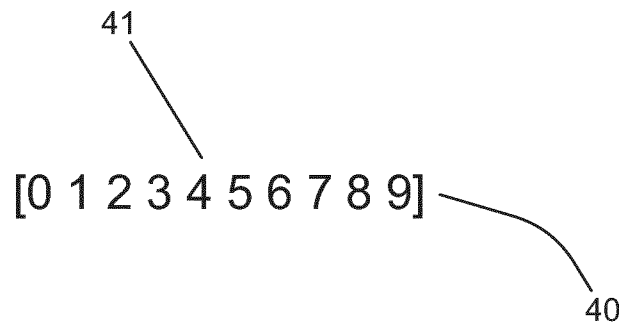


Figure 4

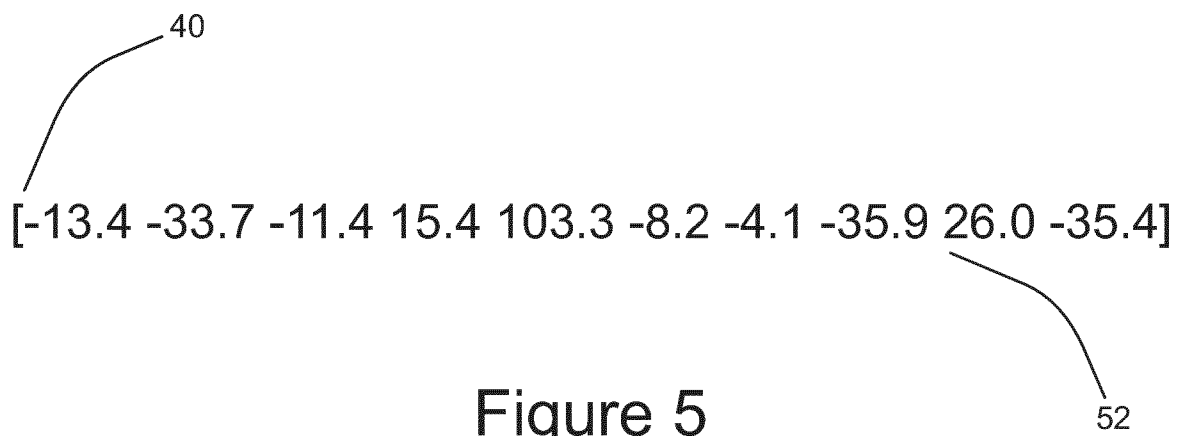


Figure 5

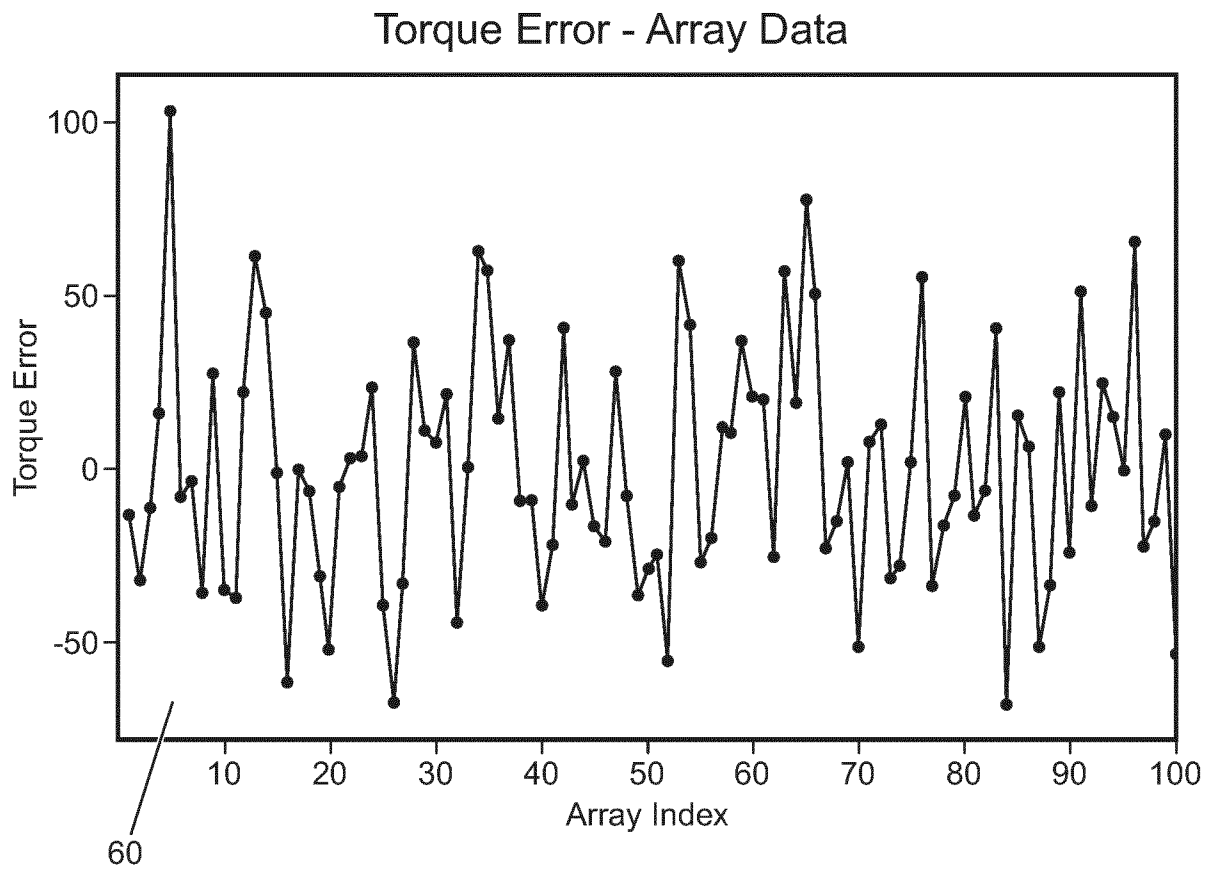


Figure 6

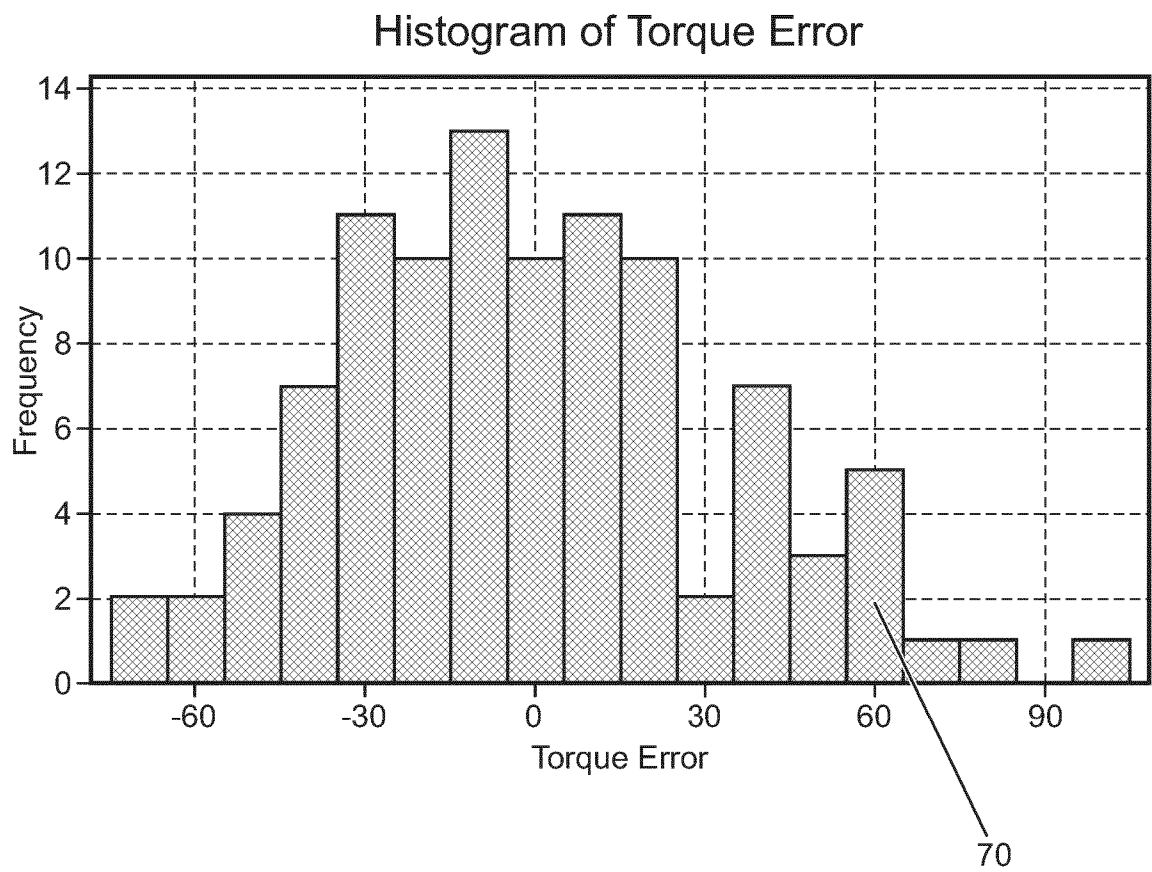


Figure 7

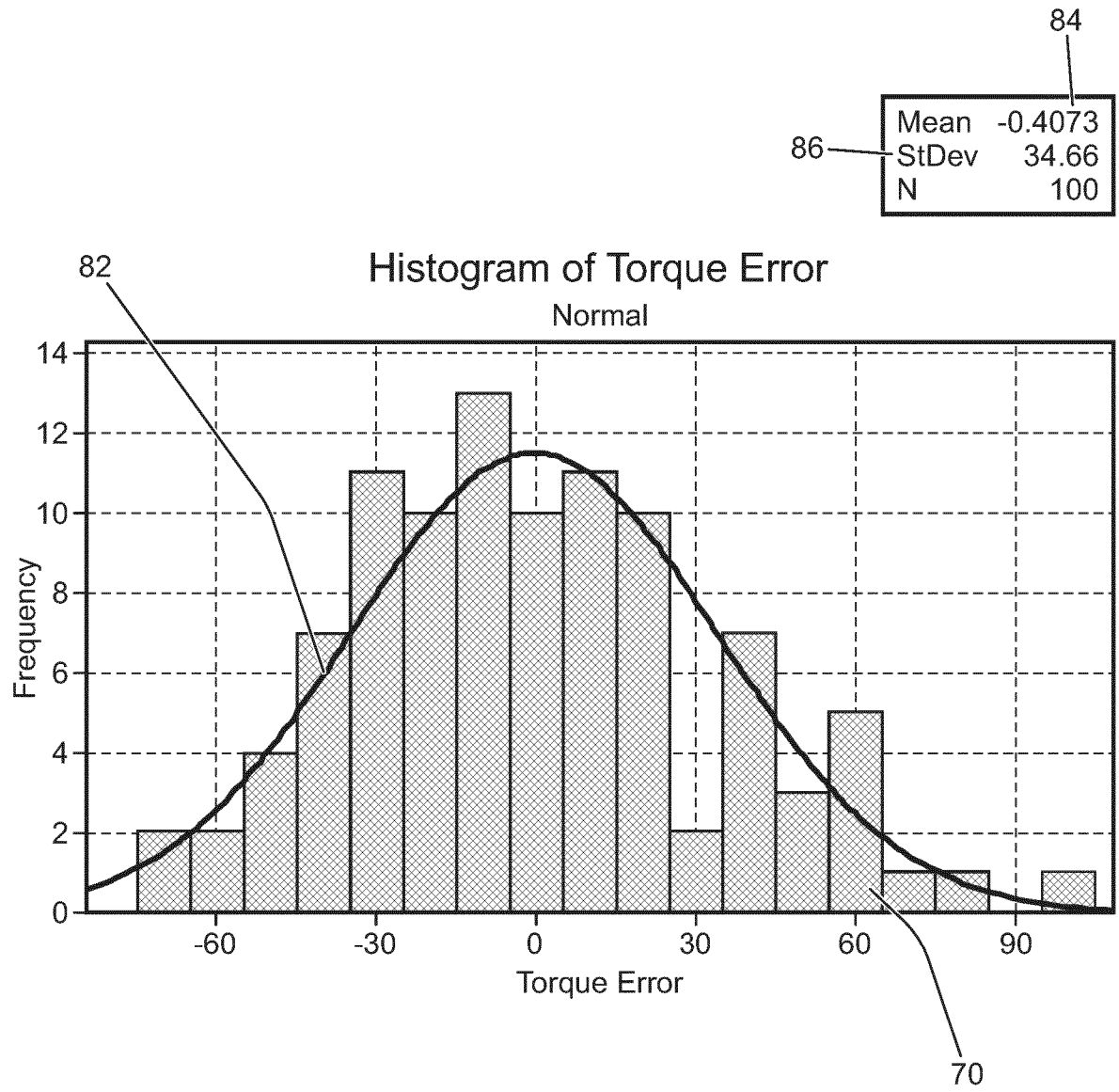


Figure 8

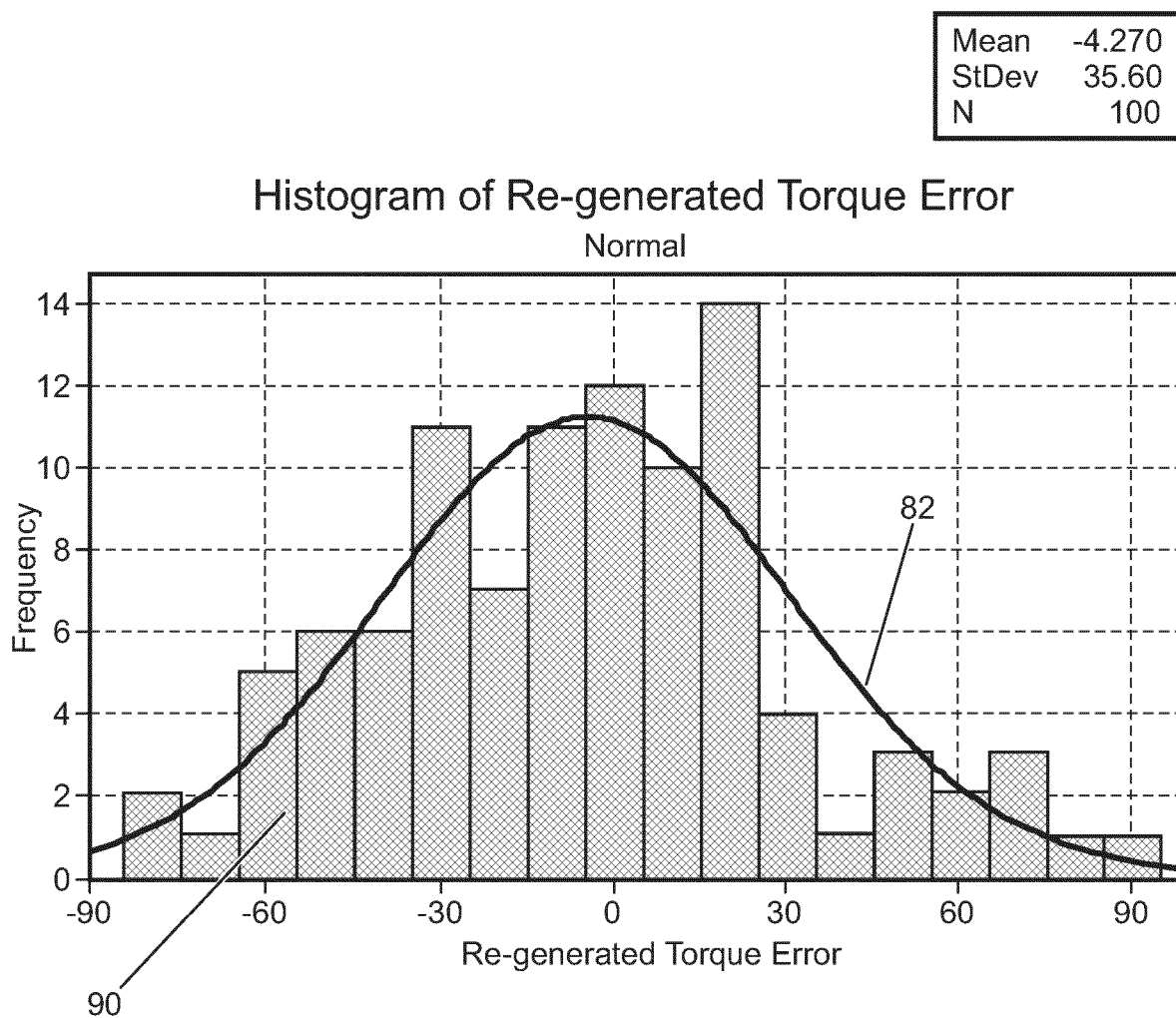


Figure 9

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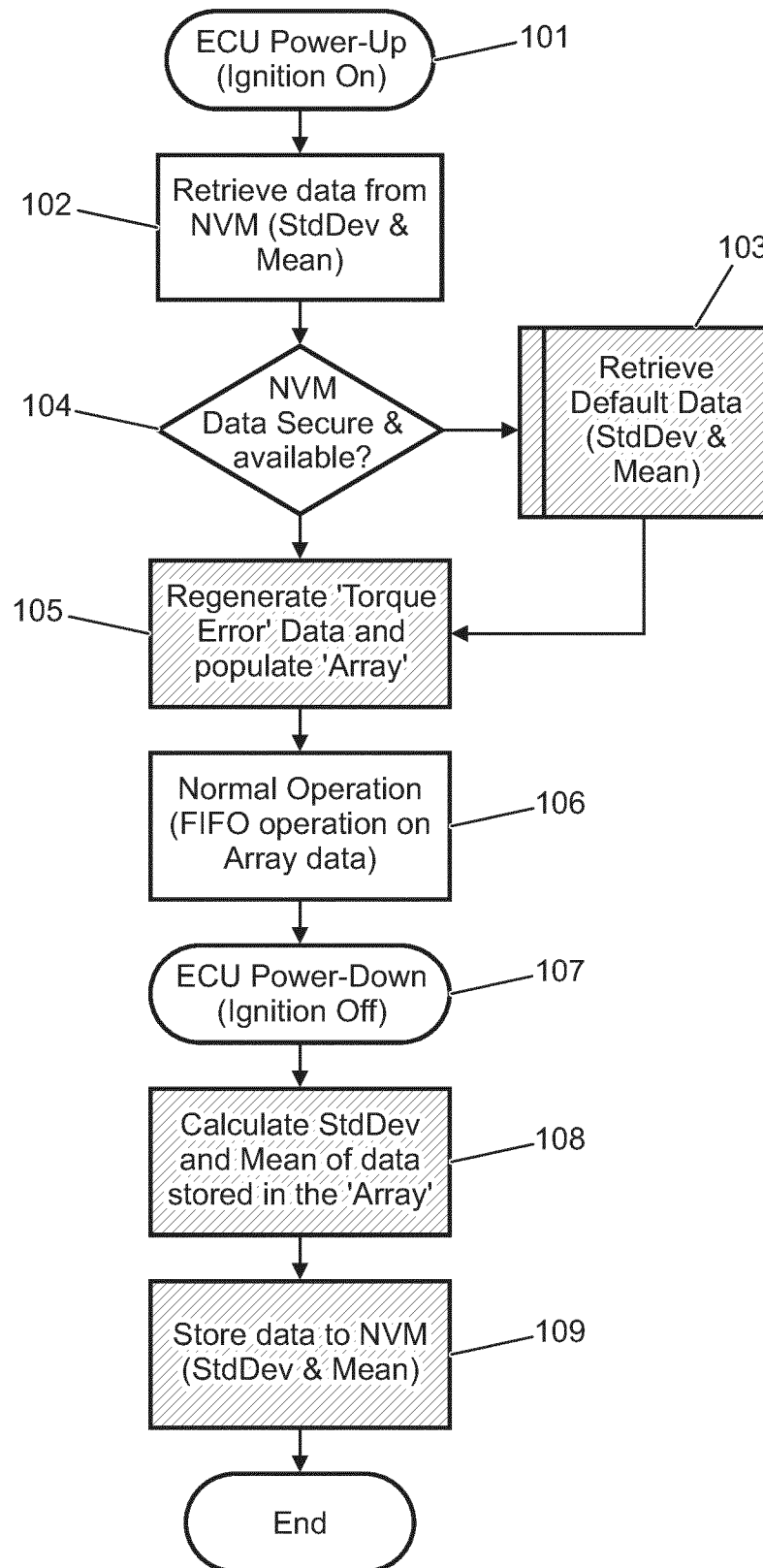


Figure 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/064027

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60W50/04 B60W50/02
ADD.

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 G06F

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015/274146 A1 (DOERING JEFFREY ALLEN [US] ET AL) 1 October 2015 (2015-10-01) paragraphs [0007] - [0010], [0018], [0045], [0067] - [0069] figure 3	1-13
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A	US 2016/035155 A1 (RICE TIMOTHY D [US] ET AL) 4 February 2016 (2016-02-04) paragraphs [0023] - [0025]	1-13
A	US 2016/068067 A1 (MARSILIA MARCO [FR]) 10 March 2016 (2016-03-10) paragraphs [0011] - [0016]	1-13
	-/-	



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

15 September 2017

Date of mailing of the international search report

26/09/2017

Name and mailing address of the ISA/

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Authorized officer

Nielles, Daniel

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/064027

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/040261 A1 (NAKAMOTO KATSUYA [JP] ET AL) 4 April 2002 (2002-04-04) paragraphs [0013] - [0015] -----	1-13
A	US 2013/173110 A1 (FUEHRER THOMAS [DE]) 4 July 2013 (2013-07-04) paragraph [0026] -----	1-13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2017/064027

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 14
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 14

Claim 14 lacks clarity to such an extent that no search is possible (Art. 6, Rule 6.2 PCT).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/064027

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