(51) International Patent Classification:
F16D 49/08 (2006.01)

(21) International Application Number:
PCT/EP20 16/054042

(22) International Filing Date:
26 February 2016 (26.02.2016)

(25) Filing Language:
English

(26) Publication Language:
English

(30) Priority Data:
1504054.6 10 March 2015 (10.03.2015) GB

(71) Applicant: JAGUAR LAND ROVER LIMITED [GB/GB]; Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).

(72) Inventors: GABELA, Philip; c/o Jaguar Land Rover, Patents Department W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB). AFTANASA, Florin; c/o Jaguar Land Rover, Patents Department W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).

(74) Agent: BORTON, Claire; c/o Jaguar Land Rover, Patents Department W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).


(54) Title: CLUTCH CONTROL FOR PROVIDING AN INDICATION TO A DRIVER

(57) Abstract: An illustrative example embodiment of a system for providing an indication to a driver includes a clutch that is at least partially automatically controllable and clutch control means configured to control the clutch in a manner that results in a haptic indication to a driver based on at least one predefined condition. In an example embodiment, the clutch control includes automatically adjusting an amount of clutch engagement to provide the haptic indication.

[Continued on next page]

Published: with international search report (Art. 21(3))
CLUTCH CONTROL FOR PROVIDING AN INDICATION TO A DRIVER

TECHNICAL FIELD
The present disclosure relates to clutch control for providing an indication to a driver. More particularly, but not exclusively, the present disclosure relates to controlling a clutch to provide an indication to a driver regarding a condition of a vehicle. Aspects of the invention relate to a system, a vehicle and a method.

BACKGROUND
Automotive vehicles typically include a transmission for delivering torque produced by the engine to the wheels. A clutch selectively couples the engine with the transmission in a well-known manner. Manual transmissions typically require the driver to select a gear and to control clutch engagement by using a clutch pedal, for example. Automatic transmissions do not require manual gear selection or clutch control.

With manual transmissions, it is possible for a driver to reduce vehicle speed without changing a current gear of the transmission. If the transmission is in too high of a gear there may be consistency issues between the engine speed and the transmission gear that interfere with further vehicle movement. For example, after the vehicle has come to rest, it may not be possible to launch the vehicle without changing gears. Under such circumstances it would be useful to be able to prompt the driver to take action.

It is an aim of embodiments of this invention to avoid drawbacks or shortcomings associated with known systems.

SUMMARY OF THE INVENTION
An illustrative example embodiment of a system for providing an indication to a driver includes a clutch that is at least partially automatically controllable and clutch control means for controlling the clutch in a manner that results in a haptic indication to a driver based on at least a need to shift a gear of an associated transmission.

In an embodiment having one or more features of the system of the previous paragraph, the clutch control means automatically adjusts an amount of engagement of the clutch to cause the haptic indication.
In an embodiment having one or more features of the system of any of the previous paragraphs, the clutch control means automatically and repeatedly causes engagement of the clutch to increase and decrease.

In an embodiment having one or more features of the system of any of the previous paragraphs, the clutch control means automatically causes clutch engagement to oscillate between two engagement conditions.

In an embodiment having one or more features of the system of any of the previous paragraphs, the haptic indication comprises vibration of at least one component associated with the clutch.

In an embodiment having one or more features of the system of any of the previous paragraphs, the haptic indication simulates an impending engine stall.

An illustrative example embodiment of a vehicle includes the system of any preceding paragraph, an engine associated with the clutch, and the transmission associated with the clutch. The automatically controlling of an at least partially automatically controllable clutch in a manner that results in a haptic indication to a driver is further based on a speed of the engine corresponding to a vehicle stop, the driver indicating a desire to increase the speed of the engine, and the transmission being in a gear that is not suitable to start movement of the vehicle from stop.

In an embodiment having one or more features of the vehicle of the previous paragraph the haptic indication is intended to prompt the driver to shift the transmission into a different gear.

In an embodiment having one or more features of the vehicle of any of the previous paragraphs the clutch is manually controllable and the transmission is manually controllable.

An illustrative example embodiment of a method of providing an indication to a driver includes automatically controlling an at least partially automatically controllable clutch in a manner that results in a haptic indication to a driver based on at least a need to shift a gear of an associated transmission.
An embodiment having one or more features of the method of the previous paragraph includes automatically adjusting an amount of engagement of the clutch to cause the haptic indication.

An embodiment having one or more features of the method of any of the previous paragraphs includes automatically and repeatedly causing engagement of the clutch to increase and decrease.

An embodiment having one or more features of the method of any of the previous paragraphs includes automatically causing clutch engagement to oscillate between two engagement conditions.

In an embodiment having one or more features of the method of any of the previous paragraphs, the haptic indication comprises vibration of at least one component associated with the clutch.

In an embodiment having one or more features of the method of any of the previous paragraphs, the haptic indication simulates an impending engine stall.

In an embodiment having one or more features of the method of any of the previous paragraphs, the automatically controlling of an at least partially automatically controllable clutch in a manner that results in a haptic indication to a driver is further based on an attempted start from stop of an associated vehicle.

In some but not necessarily all examples of the present disclosure there is provided a system for providing an indication to a driver includes a clutch that is at least partially automatically controllable and clutch control means for controlling the clutch in a manner that results in a haptic indication to a driver based on at least one predefined condition.

In some but not necessarily all examples of the present disclosure there is a method of providing an indication to a driver includes automatically controlling an at least partially automatically controllable clutch in a manner that results in a haptic indication to a driver based on at least one predefined condition.
Aspects and embodiments of the invention provide a system, a vehicle, and a method claimed in the appended claims;

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 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.

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 diagrammatically illustrates an example embodiment of a vehicle including a driver indicator system designed according to an embodiment of this invention;

Figure 2 schematically illustrates selected portions of a vehicle including a driver indicator system designed according to an embodiment of this invention;

Figure 3 is a flowchart diagram summarizing an example driver indication strategy; and

Figures 4A-4D illustrate an example scenario including clutch control for providing an indication to a driver according to an embodiment of this invention.

DETAILED DESCRIPTION

Figures 1 and 2 illustrate selected features of a vehicle 20. A clutch 22 selectively couples an engine 24 and transmission 26 for delivering torque to wheels 28 to cause desired movement of the vehicle 20. The clutch 22 in this example is at least partially automatically controllable. A clutch control means 30 is provided for controlling or modifying operation of the clutch 22 under selected circumstances. The clutch control means 30 in some examples comprises a processor
or electronic controller that is suitably programmed to achieve the desired clutch control. The processor may be a dedicated or distinct device or may be a portion of a processor that performs other functions or operations. Some embodiments include several processors that contribute to clutch control, such as by communicating over a network.

The example of Figure 2 includes a manual clutch control means 32 for allowing a driver to manually control whether the clutch 22 is released or engaged. In some examples, the manual clutch control means 32 comprises a clutch pedal that may be manipulated by a driver to control the engagement of the clutch 22.

In the illustrated example, the transmission 26 is a manual transmission. A gear selection means 34 for manually selecting a gear provides manual control to a vehicle driver. In one example, the gear selection means comprises a stick shift mechanism or a moveable handle that can be manipulated to select a gear.

A supervisory control means 36 monitors information regarding vehicle performance, a condition of the engine 24, clutch 22 and transmission 26. In this example, the supervisory control means 36 communicates with the clutch control means 30 under selected conditions to provide information to the clutch control means 30 for controlling the clutch 22 in a manner that provides an indication to a driver of the vehicle 20 regarding a condition that requires driver attention, for attention. The supervisory control means 36 in some embodiments comprises a processor suitably programmed according to the needs of a particular vehicle and system embodiment. While the clutch control means 30 and the supervisory control means 36 are illustrated separately in Figure 2, it is possible to realize both of them using a single processor unit.

Those skilled in the art who have the benefit of this description will realize what combination of electronics, software and firmware will best meet their particular needs.

Figure 3 is a flowchart diagram 40 summarizing an example approach for providing an indication to a driver. At 42, a determination is made that a condition exists that requires driver attention or response. The supervisory control means 36 makes this determination according to an example embodiment. At 44, the clutch control means 30 controls the clutch 22 in a manner that provides a haptic indication to a driver regarding a condition that was determined to exist at 42. At 46, a determination is made whether the condition has been resolved. If not, the clutch
control at 44 continues until the condition has been resolved or a preset time limit has expired, or a different strategy is implemented. Once the condition has been resolved, the supervisory control means 36 continues monitoring whether another condition exists that may require providing an indication to a driver.

One example situation in which a haptic driver indication would be useful is when a driver has reduced the speed of the vehicle while leaving the transmission 26 in a high gear. If the driver brings the vehicle to a rest, for example, starting the vehicle from stop requires the transmission 26 to be in a suitable gear, such as first gear. If the driver has not shifted out of a higher gear utilized prior to bringing the vehicle to a stop, the vehicle may not be successfully launched.

Figures 4A-4D illustrate an example scenario in which controlling the clutch 22 is useful for providing a haptic indication to the driver that can prompt the driver to shift gears so that a successful start from stop launch may occur. Figure 4A includes a plot 50 of engine speed over time. As shown at 52, the engine speed decreases as the driver slows the vehicle down. In this particular example, the vehicle is brought to a stop and the engine speed is shown at zero in Figure 4A. Figure 4B includes a plot 60 showing the currently engaged gear of the transmission 26. As can be appreciated by comparing Figures 4A and 4B, the transmission remains in sixth gear even though the driver has brought the vehicle to a stop.

Referring to Figures 4A and 4C, the engine speed increases at 54 as the driver indicates a desire to launch the vehicle from stop. Figure 4C includes a plot 70 showing an engine start request initiated at 72. As can be appreciated from Figures 4A and 4C, the engine speed begins to increase at 54 at the engine start request 72. Given that the transmission is currently in sixth gear as shown at 62, the supervisory control means 36 determines that driver attention is required for shifting the transmission 26 into a lower gear. The supervisory control means 36 communicates with the clutch control means 30 so that the clutch control means 30 may automatically control the clutch 22 in a manner that will provide a haptic indication to the driver for prompting the driver to shift gears.

Figure 4D includes a plot 80 showing automatic clutch position control achieved by the clutch control means 30. Given that engine speed is increasing at 54 and the transmission is currently in sixth gear as shown at 62, the clutch control means 30 automatically adjusts engagement of the clutch 22 in a manner that repeatedly alters the engagement as shown at 82. In this
example, the amount of clutch engagement is varied or oscillated about a biting point shown at 84. The result of controlling the clutch in this way causes vehicle vibration or movement that simulates an impending engine stall. The driver will haptically notice the simulated stall behaviour and realize that attention is required for launching the vehicle from stop. In some situations, the driver may instinctively downshift into a lower gear. In some embodiments, a separate visual or audible indication may also be provided to the driver indicating that the gear selection means 34 should be manipulated to shift the transmission 26 into a lower gear.

As can be appreciated from Figures 4B and 4D, once the driver downshifts into first gear, the automated clutch control changes as shown at 86 corresponding to the gear change.

In some embodiments, the clutch control means 30 monitors driver operation of the manual clutch control means 32 for purposes of determining whether to allow the manual clutch control to override automatic clutch control based upon information that the driver is utilizing the gear selection means 34 and the manual clutch control means 32 in a manner that indicates that the driver is attempting to shift the transmission 26 into an appropriate gear for launching the vehicle from rest. In some embodiments, the automatic control over the clutch 22 continues until the driver realizes to shift the transmission into an appropriate gear and the driver is not required to utilize manual control over the clutch under such conditions. In some embodiments, the automated clutch control associated with providing a haptic indication to the driver overrides any attempt by the driver to manually control the clutch engagement condition.

While a vehicle start from stop condition is described as an example scenario in which a haptic indication can be provided to a driver, embodiments of this invention are not limited to that scenario. Those skilled in the art who have the benefit of this description will realize other conditions in which automated clutch control for providing a haptic indication to a driver will be useful. As can be appreciated from this description, embodiments of this invention allow for providing a haptic indication to a driver to alert the driver to a situation or condition that requires some action or response from the driver.
CLAIMS:

1. A system for providing an indication to a driver, comprising:
   a clutch that is at least partially automatically controllable; and
   clutch control means for controlling the clutch in a manner that results in a haptic
   indication to a driver based on at least a need to shift a gear of an associated transmission.

2. The system of claim 1, wherein the clutch control means automatically adjusts an
   amount of engagement of the clutch to cause the haptic indication.

3. The system of claims 1 or 2, wherein the clutch control means automatically and
   repeatedly causes engagement of the clutch to increase and decrease.

4. The system of any preceding claim, wherein the clutch control means automatically
   causes clutch engagement to oscillate between two engagement conditions.

5. The system of any preceding claim, wherein the haptic indication comprises vibration of
   at least one component associated with the clutch.

6. The system of any preceding claim, wherein the haptic indication simulates an
   impending engine stall.

7. A vehicle comprising the system of any preceding claim and comprising
   an engine associated with the clutch; and
   the transmission associated with the clutch;
   wherein the automatically controlling of an at least partially automatically controllable
   clutch in a manner that results in a haptic indication to a driver is further based on:
   a speed of the engine corresponding to a vehicle stop;
   the driver indicating a desire to increase the speed of the engine; and
   the transmission being in a gear that is not suitable to start movement of the vehicle from
   stop.

8. The vehicle of claim 7, wherein the haptic indication is intended to prompt the driver to
   shift the transmission into a different gear.
9. The vehicle of claim 7 or 8, wherein
   the clutch is manually controllable; and
   the transmission is manually controllable.

10. A method of providing an indication to a driver, comprising:
    automatically controlling an at least partially automatically controllable clutch in a manner
    that results in a haptic indication to a driver based on at least a need to shift a gear of an
    associated transmission.

11. The method of claim 10, comprising automatically adjusting an amount of engagement
    of the clutch to cause the haptic indication.

12. The method of claims 10 or 11, comprising automatically and repeatedly causing
    engagement of the clutch to increase and decrease.

13. The method of any of claims 10-12, comprising automatically causing clutch
    engagement to oscillate between two engagement conditions.

14. The method of any of claims 10-13, wherein the haptic indication comprises vibration of
    at least one component associated with the clutch.

15. The method of any of claims 10-14, wherein the haptic indication simulates an
    impending engine stall.

16. The method of claim 10, wherein the automatically controlling of an at least partially
    automatically controllable clutch in a manner that results in a haptic indication to a driver is
    further based on an attempted start from stop of an associated vehicle.

17. A vehicle, a system or a method substantially as hereinbefore described with reference
    to the accompanying drawings.
Determine that condition exists that requires driver attention or response

Control clutch to provide haptic indication driver

Condition resolved?

FIG. 3
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16D48/08

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):

F16D

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

<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>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>DE 10 2011 104085 AI (SCHAEFFLER TECHNOLOGIES AG [DE]) 20 December 2012 (2012-12-20) claims 1, 5, 7, 8</td>
<td>1-6, 10-15, 17</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>7-9</td>
</tr>
<tr>
<td>X</td>
<td>US 4 499 450 A (MAKITA FUJI0 [JP]) 12 February 1985 (1985-02-12) column 3, line 36; claims 1-5</td>
<td>1, 5, 6, 10, 15, 17</td>
</tr>
<tr>
<td>X</td>
<td>EP 1 616 770 AI (LUK LAMELLEN &amp; KUPPLUNGSBAU [DE]) 18 January 2006 (2006-01-18) claim 9</td>
<td>1, 10, 17</td>
</tr>
<tr>
<td>X</td>
<td>WO 03/087614 AI (LUK LAMELLEN &amp; KUPPLUNGSBAU [DE] ; REIBOLD EKKEHARD [DE] ; MOOSHEIMER JO) 23 October 2003 (2003-10-23) claims 1, 8, 12, 14, 15, 19</td>
<td>1, 2, 10, 16</td>
</tr>
</tbody>
</table>

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

"Z" document member of the same patent family

Date of the actual completion of the international search 19 May 2016

Date of mailing of the international search report 31/05/2016

Name and mailing address of the ISA/ Authorized officer

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040
Fax. (+31-70) 340-3016

Garcia y Garmendia

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE 102011104085 AI</td>
<td>20-12-2012</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 4499450 A</td>
<td>12-02-1985</td>
<td>DE 3206593 AI</td>
<td>09-12-1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2500552 AI</td>
<td>27-08-1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 2093618 A</td>
<td>02-09-1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP S642819 B2</td>
<td>18-01-1989</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP S57140925 A</td>
<td>31-08-1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NL 8200710 A</td>
<td>16-09-1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 4499450 A</td>
<td>12-02-1985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1616770 AI</td>
<td>18-01-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 395230 T</td>
<td>15-05-2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1715110 A</td>
<td>04-01-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1616770 AI</td>
<td>18-01-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2006017306 A</td>
<td>19-01-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 20060066609 A</td>
<td>16-06-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2006004506 A</td>
<td>05-01-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2838489 AI</td>
<td>17-10-2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 03087614 AI</td>
<td>23-10-2003</td>
</tr>
</tbody>
</table>