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(12) **United States Patent**
Boisvert et al.

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(45) **Date of Patent: *Jul. 10, 2012**

(54) **COLLISION MONITORING SYSTEM**

(75) Inventors: **Mario Boisvert**, Reed City, MI (US); **Randall Perrin**, Grawn, MI (US); **John Washeleski**, Cadillac, MI (US)

(73) Assignee: **Uusi, LLC**, Reed City, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 405 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/360,942**

(22) Filed: **Jan. 28, 2009**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 10/100,892, filed on Mar. 18, 2002, now Pat. No. 7,548,037, which is a continuation-in-part of application No. 09/562,986, filed on May 1, 2000, now Pat. No. 6,404,158, which is a continuation-in-part of application No. 08/736,786, filed on Oct. 25, 1996, now Pat. No. 6,064,165, which is a continuation of application No. 08/275,107, filed on Jul. 14, 1994, now abandoned, which is a continuation-in-part of application No. 07/872,190, filed on Apr. 22, 1992, now Pat. No. 5,334,876.

(60) Provisional application No. 60/169,061, filed on Dec. 6, 1999.

(51) **Int. Cl.**
G05D 3/00 (2006.01)

(52) **U.S. Cl.** **318/466**; 318/264; 318/265; 318/266; 318/280; 318/282; 318/286; 318/461; 318/468; 318/469

(58) **Field of Classification Search** ..... None
See application file for complete search history.

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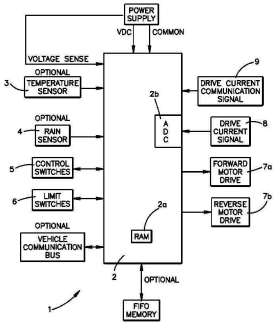
(74) *Attorney, Agent, or Firm* — Tarolli, Sundheim, Covell & Tummino LLP

(57) **ABSTRACT**

Disclosed is an improved system and method for sensing both hard and soft obstructions for a movable panel such as a sunroof. A dual detection scheme is employing that includes an optical sensing as the primary means and electronic sensing of motor current as a secondary means. The secondary means utilizes system empirical precharacterization, fast processing algorithms, motor parameter monitoring including both current sensing and sensorless electronic motor current commutation pulse sensing, and controller memory, to adaptively modify electronic obstacle detection thresholds in real time without the use of templates and cycle averaging techniques.

10 Claims, 9 Drawing Sheets



US007579802B2

(12) **United States Patent**
Boisvert et al.

(10) **Patent No.: US 7,579,802 B2**
(45) **Date of Patent: Aug. 25, 2009**

(54) **COLLISION MONITORING SYSTEM**

(75) Inventors: **Mario Boisvert**, Reed City, MI (US); **Randall Perrin**, Grawn, MI (US); **John Washeleski**, Cadillac, MI (US)

(73) Assignee: **Nartron Corporation**, Reed City, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 550 days.

(21) Appl. No.: **10/765,487**

(22) Filed: **Jan. 27, 2004**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Division of application No. 10/100,892, filed on Mar. 18, 2002, which is a continuation-in-part of application No. 09/562,986, filed on May 1, 2000, now Pat. No. 6,404,158, which is a continuation-in-part of application No. 08/736,786, filed on Oct. 25, 1996, now Pat. No. 6,064,165, which is a continuation of application No. 08/275,107, filed on Jul. 14, 1994, now abandoned, which is a continuation-in-part of application No. 07/872,190, filed on Apr. 22, 1992, now Pat. No. 5,334,876.

(51) **Int. Cl.**
G05D 3/00 (2006.01)

(52) **U.S. Cl.** **318/466**; 318/467; 318/468; 318/469; 318/476

(58) **Field of Classification Search** 318/264–266, 318/280–286, 460–470, 565, 626, 434, 139, 318/474–477, 815, 833, 903; 701/36, 49
See application file for complete search history.

(56) **References Cited**

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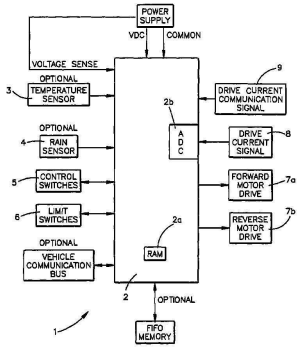
Primary Examiner—Marlon T Fletcher
(74) *Attorney, Agent, or Firm*—Tarolli, Sundheim, Covell & Tummino LLP

(57) **ABSTRACT**

Disclosed is an improved system and method for sensing both hard and soft obstructions for a movable panel such as a sunroof. A dual detection scheme is employing that includes an optical sensing as the primary means and electronic sensing of motor current as a secondary means. The secondary means utilizes system empirical precharacterization, fast processing algorithms, motor parameter monitoring including both current sensing and sensorless electronic motor current commutation pulse sensing, and controller memory, to adaptively modify electronic obstacle detection thresholds in real time without the use of templates and cycle averaging techniques.

22 Claims, 9 Drawing Sheets



"REAL WORLD" AUTOMOBILES: REDUCTION OF FALSE POSITIVES AND FALSE NEGATIVES FOR SOFT AND HARD OBSTACLE DETECTION

BACKGROUND

National Highway Traffic Safety Administration (NHTSA) Standard 118 contains regulations to assure safe operation of power-operated windows and roof panels. It establishes requirements for power window control systems located on the vehicle exterior and for remote control devices. The purpose of the standard is to reduce the risk of personal injury that could result if a limb catches between a closing power operated window and its window frame. Standard 118 states that maximum allowable obstacle interference force during an automatic closure is less than 100 Newton onto a solid cylinder having a diameter from 4 millimeters to 200 millimeters.

Certain technical difficulties exist with operation of prior art automatic power window controls. One difficulty is undesirable shutdown of the power window control for causes other than true obstacle detection. Detection of obstacles during startup energization, soft obstacle detection, and hard obstacle detection each present technical challenges requiring multiple simultaneous obstacle detection techniques. Additionally, the gasket area of the window that seals to avoid water seepage into the vehicle presents a difficulty to the design of a power window control, since the window panel encounters significantly different resistance to movement in this region. Operation under varying power supply voltage results in actuator speed variations that result in increased obstacle detection thresholds.

'802 Patent, Col. 1

SUMMARY OF THE INVENTION

This invention concerns an improved actuator system that provides faster operation, more sensitive obstacle detection, faster actuator stopping with reduced pinch force, and reduced false obstacle detection all with less costly hardware.

25. For example, see "[a]lgorithm processing for hard and soft obstruction detection is divided into two separate equations, weighting the various terms depending upon magnitude of importance and processing time requirements." The '802 Patent at 22:44-47. An example embodiment of hard obstruction detection "essentially compares immediate average current with immediately prior average current and immediately prior average pulse period...." The '802 Patent at 22:63-65. An example embodiment of soft obstruction detection is

described as: "Soft obstruction detection is not nearly as time sensitive, as is hard obstruction detection, thus additional terms can be computed in the time allowed before the slow increase in entrapment force exceeds maximum allowable values." The '802 Patent at 23:10-13.

26. Therefore, it is my understanding and belief that production automobiles prior to April of 1992 did not employ any control logic that sensed or monitored hard and soft obstacle detection while practically accounting for real-world operating conditions including wind buffeting, cold versus hot temperature effects on the window weatherstrips, vehicular voltage variations, G-forces while hitting holes in the road, and the like. Unfortunately, even after the inventions

20. Adding motor control circuitry, which may be able to detect an obstruction before the motor reaches its stall current, would allow for more powerful motors and therefore faster window closing cycles. More importantly, the motor control circuitry would ideally be able to limit the amount of force applied to an obstruction, thereby limiting or eliminating the risk of injury. In the years leading up to 1992, automotive suppliers were unable to bring motor control circuitry to market due to excessive false positives or excessive false negatives, or sometimes both.

21. A false positive is when an obstruction is detected (which may cause the window to stop and/or reverse) even though there is in fact no obstruction present. This is a nuisance and a significant concern to original equipment manufacturers concerned with perceived quality. False positives may also have an impact on safety, such as by distracting a driver from operating the vehicle when determining why the window has not responded as expected. A false negative is

when an obstruction that is actually present is not detected. This may lead to damage to the window, the motor, the lift mechanism, or worse, to a person whose body part is caught between the window and the window seal.

...

23. The 1992 priority application is the practical development of a system that, in real world scenarios, exhibits a very low false positive rate and an even lower false negative rate. For example only, real world scenarios may include conditions experienced by many moving object systems, such as mechanical wear and friction changes in response to heat. The conditions may also include situations more specific to motor vehicles, such as ice buildup, fluctuating power supply voltage from the alternator and/or battery, or static pressure changes due to, for example, ventilation changes. Static pressure changes may change the amount of force the window applies against the seal, and therefore change the

amount of friction experienced by the window. Further, the conditions may include conditions unique to a vehicle in motion, such as wind buffeting.

24. The 1992 priority application achieves these results by, among a number of inventive details, concurrently using multiple obstacle detection algorithms. The obstacle detection algorithms are selected to detect different forms of obstacles, such as hard obstacles (for example, a bone) and soft obstacles (for example, a person's throat). Each obstacle detection algorithm may be set with less aggressive parameters than if the obstacle detection algorithm were the only one in use, thereby reducing false positives. By using multiple obstacle detection algorithms, the various obstacle types can each be detected more accurately according to the parameters that characterize them respectively, reducing false negatives.

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