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Anti-Pinch Protection Approaches on Smart Tailgate

By Satish Ullatil

Abstract- An improved system for detecting the presence of an object in the path of a liftgate relies upon the sensor and transmitters those used for collision avoidance systems to detect the presence of an object when the tailgate is closed in auto-mode. The sensors are actuated when the liftgate is moved to its closed position. When an object is detected, further movement of the liftgate stops rearward accordingly. Now a day, the capacitive sensors are widely used for the anti-pinch system considering the production cost and adaptability. Pedestrians are in at risk of meeting with fatal accidents or tailgate get mal-function due to the presence of the hard object. Car manufacturers have initiated to support by offering collision avoidance systems that detect pedestrians and objects on the powered tailgate.

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Anti-Pinch Protection Approaches on Smart Tailgate

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I. Introduction

Pedestrians, occupants are particularly at risk of meeting with fatal accidents or mal-function of the tailgate system while closing on auto mode. In most of the accidents, the pedestrian intrude with the tailgate un-intentionally while the tailgate closes in auto mode. The requirement of anti-pinch protection sensor detection is essential in high advanced vehicles as with the aid of sensor, it senses the human or object interface while closing. It has an obvious extension to automotive applications due to the potential for improving safety systems. Product OEM's have developed different electronic system for active smart tailgate which are safe and cost-effective solution and also fulfil the legal requirements for pedestrian protection on vehicles and predictive pedestrian protection system which can detect impending accidents or mal-functioning of the tailgate due to damage on force-full closing.

II. Objective

The objective of the paper is to provide the different approaches and methods to reduce the pedestrian fatal injuries or accidents by integrating the anti-pinch safety feature on vehicle tailgate which detect human movement or object on the tailgate in auto operating condition.

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III. Anti-Pinch Technology

It is a safety system which prevents fatal accidents and the application mal-function of powered Tailgate while operating in auto-mode.

This feature stops the tailgate's download movement when something is preventing the tailgate from closing.

There are different sensors available to implement the anti-pinch application on the powered tailgate. The types are listed below.

1. Tactile Sensor
2. Capacitive Sensor
3. Sensor Profile
4. Ultrasonic Sensor

The Anti-Pinch feature is added to one touch open powered smart tailgate of PO IES upcoming trend as part of an innovative feature addition.

a) Tactile Sensor

The tactile sensor has a character to reacts to even slight pressure, force and are sensitive to touch. The sensors are made using light optical electricity. When the tactile sensor activate, the control unit of power tailgate receives a signal and after, a very less reaction time, aims a reversal of automatic opening movement.

Tactile sensors measure the coming information in response to physical interaction with the environment. The sense of touch in human is generally modeled i.e. cutaneous sense and kinesthetic sense.

Fig. 1: Tactile sensor mounted on door seals [1]

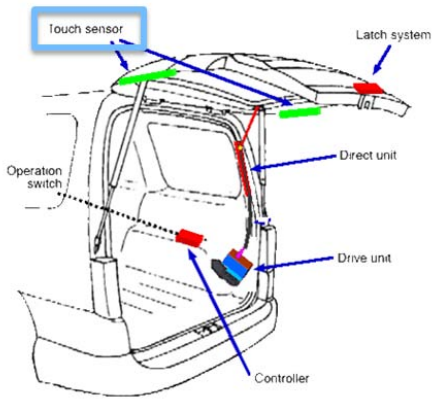


Fig. 2: Tactile sensor

b) Capacitive Sensor

Capacitive sensors tend to change the electrical field, if a person approaches the active zone of the sensor. The information is evaluate by the control unit and forwarded to the power tailgate. The non-touch detection system is a surface sensor. The sensor, which is only a few millimeters thicker is often mounted behind a plastic panel and divided into different zones (zone1 or zone2), offering sensitive responses wherever required.

Fig. 3: Zones of Sensing Regions

Fig. 4: Capacitive Senor attached on felt

Fig. 5: Capacitive Sensor Application

c) Sensor Profiles

Sensor profiles are 'pressure sensitive' sensors. The safety edges are sensors that provide anti-pinch protection at pinching and shearing edges. If the safety edge encounters an obstacle, a signal trigger that make it possible to stop immediately the movement.

The profile edge easily fit various bending radii and angles. A sensor may include an attachment member which is attached to a closure member. Sensor housing substantially encloses an associated pinching sensor where a neck portion connects the sensor housing to the attachment member and a seal extending from the neck portion and contacting a body portion of the vehicle when the closure member is in a closed position.

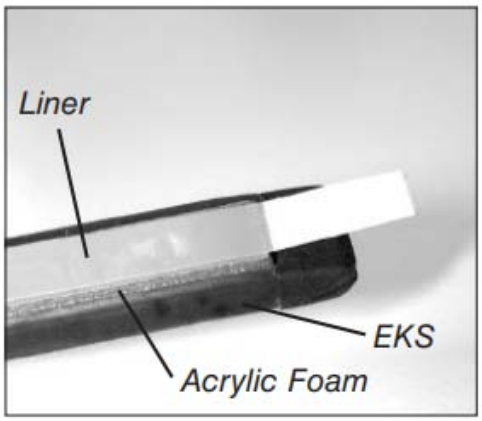


Fig. 5: Sensor Profile construction

Fig. 6: Sensor Profile position in Vehicle

Fig. 7: Sensor Profile connected to wire-harness [2]

d) Ultrasonic Sensors

Liftgate systems will include an anti-pinch algorithm system, which monitor the electrical characteristic of the motor such as current or voltage. If the electrical characteristic provides an indication that an object is in the path of the closing liftgate, then further the movement of the liftgate will be stopped, or reversed.

It is based on the ultrasonic pulse-echo method approach. The sensor senses for reflected waves on the contact with an object. The warning may be visual, audio or video.

This is adapted on powered tailgate regardless of material, form, transparency and colour. This device consists of small ultrasonic transducers that can be positioned freely and separately from electronics. They are insensitive to contamination, extraneous sound, air flows, and moisture and thus suitable for collision protection.

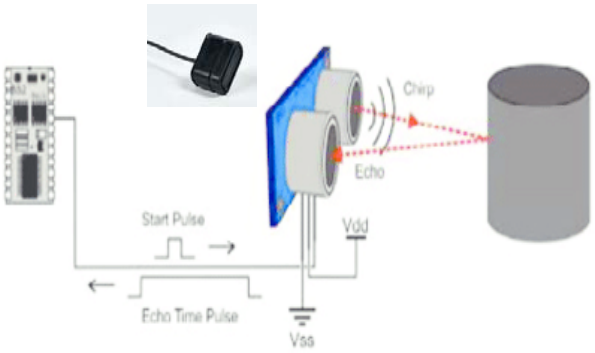


Fig. 8: Functioning of Ultrasonic sensor [3]

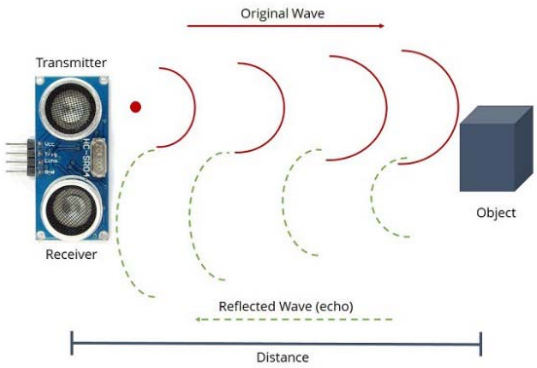
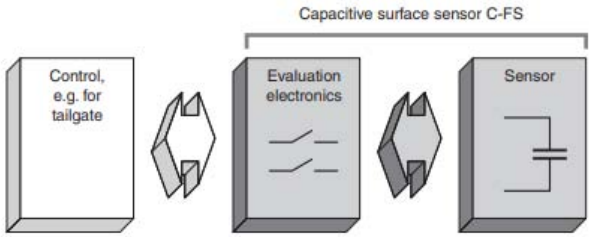


Fig. 9: Working Principle of Ultrasonic sensor

e) Working Principle of Capacitive Sensor

The capacitive sensor is used where ever powered auto tailgate must be monitored and tactile sensor are not required. This predictive technology effectively prevents collisions with persons who are in the area of the closing movement.

Principle: If a conductive object approaches the surface sensor, its capacity changes In this way, the sensor detects a person before contact is made. The connected control reverses the movement and the collusion is avoided. Since even non-conductors can hold charges, this means that just about any object can be detected with this type of sensor.



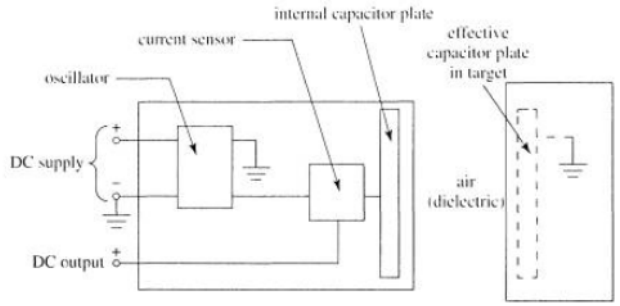
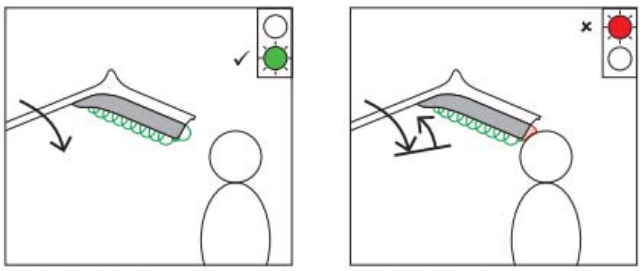


Fig. 10: Working Principle of Capacitive Sensors [3]

f) Function of Capacitive Sensor

The capacitive sensor is always surrounded by a defined capacity field. If an conductive object enters, the field changes. The sensor detects this capacitive change and causes the connected control to reverse the movement.

These types of sensor are most often used to measure the change in position of a conductive target. But capacitive sensors can be effective in measuring presence, density, thickness, and location of non-conductors as well. Non-conductive materials like plastic have a different dielectric constant than air.



Object outside
The closing movement is continued without interruption.

Object inside
Zone 2 of the sensor detects an object. The closing movement is reversed before contact is made.

Fig. 11: Functioning principle of capacitive sensor

g) Application of Capacitive Sensor

The installation is simple and reliable. The sensor is either welded on the back of a plastic applique at the defined connection points with a sonotrode or laser staked with a mandrel. The surface sensor contacts the control via the 4-pin interface type Molex Mini50TM make.

In addition to the discrete output signal, a communication signal is also available which is either of made SAE J2602 or LIN bus 2.1.

Technical Data:

Operating principle: Capacitive & Non-touch
Degree of protection: IP5K0
Standards: EN55025 & ISO 10605
Plug connection: Molex Mini 50TM

Benefits:

Reliable prevents touching & knocking over of persons
Invisible integration behind the cover
Nearly any surface geometry incl. cut-outs possible
Attachment point individually definable.
Several zone configurations are possible.

Connection point

Electronic enclosure: laser-staked on the sensor

Fig. 12: Application of capacitive sensors

IV. Advances in Technology

a) Multi-Zone Capacitive Sensor

Multi-zone Capacitive anti-pinch system is where a capacitive sensor is mounted on the tailgate and is connected to the controller which provide an output signal to the controller indicative the presence of foreign object in the path of the closure of the closure panel.

The controller varies the function of the capacitive sensor though a plurality of threshold levels as a function of the position of the closure panel as indicated by the position indicator. In a critical zone of travel with the closure panel nearing the closed position, the capacitive sensor can be utilized in either a control mode or a non-contact made or combination of both.

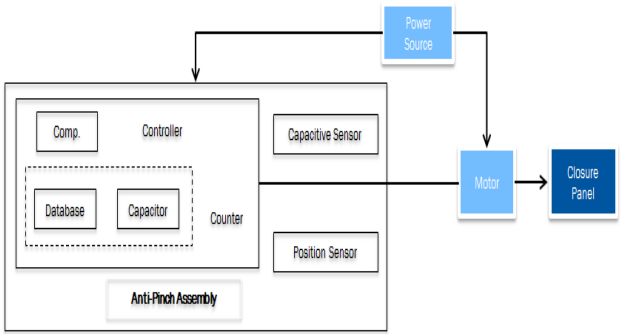


Fig. 12: Working principle of Multi-zone Capacitive Sensor [4]

b) Clipping-in Sensing Device

Provide an electrostatic capacity sensor hardly malfunctioned even in an environment splashed with water drops such as rain, or an opening and closing body clipping-in sensing device or high reliability using the same. [5] The outer surface of a sensor body and its peripheral portions are worked to get water-repellent, a detection face of the sensor main body is formed into a protruded shape, the opening and closing body is connected to a gland and the detection face of the sensor main body is arranged in a position projected to

a front door side compared with a tip of an opening and closing body end part in the opening and closing body.

c) Combined pinch/temperature sensor

A combination pinch/temperature sensor for a closure member of a motor vehicle includes a first and second pinch sensing element coupled together.

The first pinch sensing element is coupled to one of the left side and right side of the closure member for sensing a pinch condition on the corresponding side of the closure member and generating a corresponding pinch signal.

The second pinch sensing element is in electrical communication with the first pinch sensing element and is coupled to the other one of the left side and right side of the closure member for sensing a pinch condition on the other side of the closure member and generating a corresponding pinch signal. Furthermore, one of the first and second pinch sensing elements also senses an ambient temperature outside the motor vehicle and generates an ambient temperature signal for use in controlling the closure member in extreme ambient temperature conditions for powered tailgate.

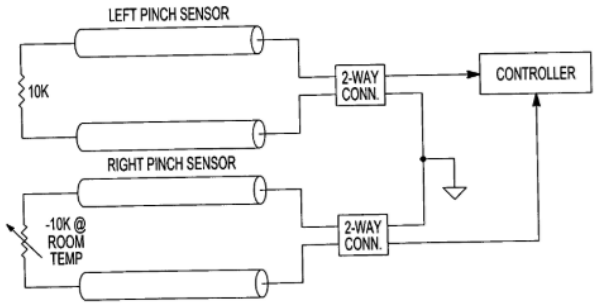


Fig. 12: Working principle of Combined Pinch Sensor

V. Conclusions

Although different collision avoidance system technologies are being developed for passenger vehicles to successfully detect pedestrians or objects in advance during vehicle tailgate closing on auto-mode to avoid fatal accidents or mal-functioning of tailgate system, the capacitive sensors are widely adapted considering the production costs, adaptability and operating cost of this technology.

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