SUDDEN UNINTENDED ACCELERATION STOPPING MECHANISM

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How Could We Detect and Safely Stop Cars When Experiencing Sudden Unintended Acceleration?

Abstract

Sudden Unintended Acceleration (SUA) is an extremely dangerous automotive issue where vehicles accelerate unexpectedly without driver input, often after attempts to brake. This scenario can cause vehicles to reach dangerous speeds within seconds, leading to fatal crashes. Despite the clear and pressing dangers of these SUA incidents, there is very little research and few effective solutions to address this problem. Current approaches mainly focus on the detection and prevention of SUA during the manufacturing process, which leaves a major gap in the protection for the millions of vehicles already on our roads.

Background

Sudden Unintended Acceleration is a critical automotive safety issue, and various researchers have explored detection and prevention methods. Kang et al. (2006) explored methods to stop SUA incidents by controlling the oil pressure in the transmission, but due to manufacturing issues, drivers cannot easily access it. Lee and Jang (2013) focused on proving SUA was a real phenomenon by using a black-box system with a foot camera, which recorded the drivers' movements, but does not directly prevent SUA incidents from occurring. Wotango et al. (2022) proposed a system that detects SUA by analyzing speed, pressure, and pedal movement, then cutting off the fuel to prevent further acceleration. While each of the studies offer valuable insights into the issue, but limitations remain prominent in the implementation, accessibility and real-world testing of the systems. This highlights the ongoing challenges of addressing SUA efficiently and effectively.

Problem Statement

Sudden Unintended Acceleration (SUA) currently does not have a global solution to automatically detect and stop a vehicle experiencing it, which can lead to fatal accidents.

Methods

Methods:

SUA Detection Sensor

1. Conducted a literature review to identify patterns in normal acceleration compared to SUA.
2. Used TinkerCAD Circuit Software to design a system that detects a vehicle's speed through motion detectors and displays the information on a screen.
   a. The display is not necessary but was useful for testing.
3. Designed a mechanism in the same circuit to measure how much the accelerator has been pressed using a distance sensor.
4. Programmed the Arduino to send a signal if both the speed and accelerator distance meet the SUA criteria identified in the literature review.

Fuel Flow Stopping System

1. Used TinkerCAD to build a new circuit that activates a motor when the SUA detection sensor sends a signal.
2. Used Fusion 360 to design a 3D model that can be attached to a pre-made fuel flow stopper, enabling the motor to turn the valve.

Criteria For Success:

Detection Sensor

1. Able to detect the speed of the car.
2. Able to detect whether the accelerator is being pressed and measure the extent of its press.
3. Able to compare real-time data and send a signal to the fuel flow stopping system.

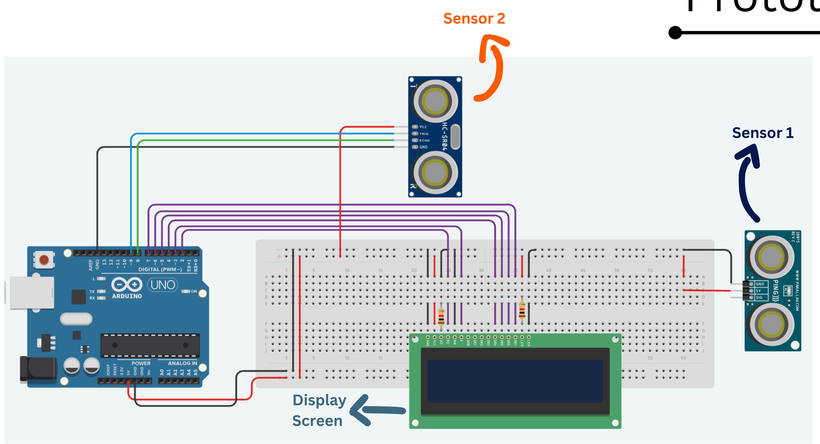
Fuel Flow Stopping System

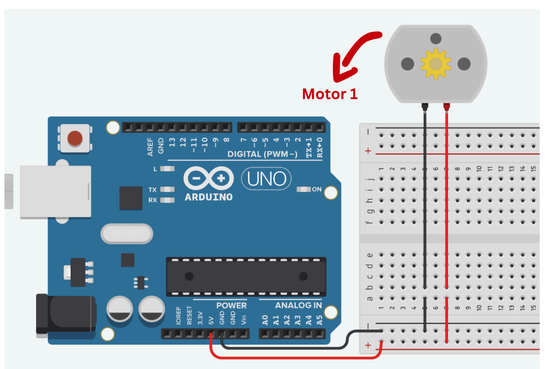
1. Able to receive a signal from the detection sensor and activate.
2. Able to turn off the fuel flow automatically without human input.

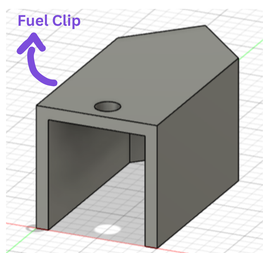
General

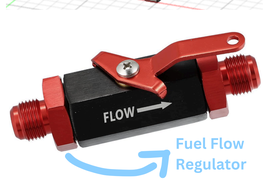
1. Must function without manual driver input.

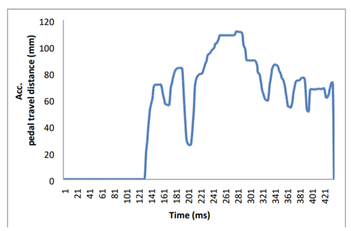
Prototype

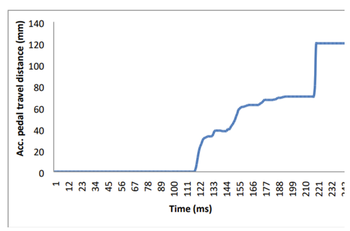












The two graphs represent the normal accelerator pattern. There should be an increase in accelerator travel distance, as shown in the graphs. If this is not present, the event is SUA.

Sensor 1 is a distance detector that measures how much the accelerator is being pressed. It will be placed underneath the accelerator pedal so that when the pedal is pressed, the detected distance decreases, indicating accelerator input. Sensor 2 is a speed detector that measures the car's velocity (the display screen shows the speed for testing purposes). If the velocity increases without any decrease in accelerator distance, it is classified as SUA and the Audrino is programmed to send a signal to the fuel flow stopping system.

The fuel clip will be attached to the handle of the fuel flow regulator, with a hole in the clip holding the motor. When the motor spins clockwise, the clip will rotate in the same direction, eventually turning the handle. This mechanism will activate when the Arduino receives a signal from the detection system.

Conclusion

The results of our prototype demonstrate strong potential in combating sudden unintended acceleration (SUA). In our simulation, the SUA detection sensor successfully identified the vehicle's speed in real-time and sent signals to the fuel flow stop control system. The control system responded appropriately to the sensor's input and with the motor and a fuel clip mechanism, it was theoretically capable of turning the valve in the fuel regulator, effectively cutting off the fuel supply to prevent further unintended acceleration.

Based on these results, we can state that our prototype achieved its primary objective of developing a theoretical framework to stop vehicles when experiencing SUA. However, it is important to acknowledge that the prototypes were tested within a simulation. Real-world variables such as sensor latency and environmental conditions were not accounted in the test.

Therefore, the next phase of this project will be constructing a physical prototype and testing it under real-world conditions. This transition from theory to practical application will allow us to refine the prototype making it reliable and real-world solution for preventing sudden unintended acceleration.

Citation

Kang, D., Yang, S., Lee, J., Lee, C., & Cho, S. (2006). A Development of the System to Prevent Unintended Sudden Acceleration by Controlling the Transmission of a Vehicle. Institute of Electrical and Electronics Engineers. https://doi.org/10.1109/ifost.2006.312233

Lee, Jungeun, & Jang, Jong wook. (2013, October). Developing integrated black-box system for proving sudden unintended acceleration of vehicles utilizing OBD-II and a camera attached to a foot. Korea Science. https://koreascience.kr/article/CFKO201331751941457.pdf

Wotango, E., Ali, P., Nallamothu, R., Kebede, S., Bekele, N., & Thanaiah, K. (2022). Collision avoidance system: Fuel cut off mechanism for unintended pressing of accelerator pedal. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4117493