Development of a Real-Time Internet-of-Things (IoT) Device to Prevent First Responders' Injuries involves with Collisions

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Problem Statement

Vehicle collision is the second highest reason for first responders' fatalities

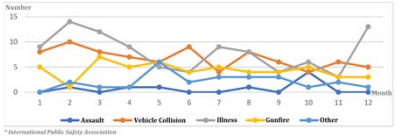


Figure 1: Data Trend by Cause of First Responder Death in 2017 (US&Canada)

Objective

1. Investigating major collision contributing factors
2. Identifying and defining the most relevant input indicators for threat analysis
3. Designing a proper threat analysis system

Rationale

- In-vehicle collision avoidance systems (e.g., automatic braking systems) designed to protect drivers/passengers and pedestrians in the case of an emergency, but few studies have investigated systems designed to detect potential threats, such as fast approaching vehicles, and warn first responders that they need to take pro-active evasive actions to avoid a collision.

Contributing Factors

The dominant collision Contributing factor (nearly 90%) is human-related activities:

- Driver's drowsiness
- Driver's distraction
- Driver's stress status
- Driver's anomalies

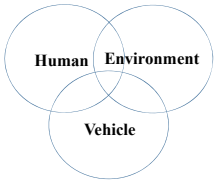


Figure 2: Collision Contributing Factors

Defining Indicators

Source of Information	Initial Input Indicator	Note
Radar system	Velocity	
	Stopping Sight Distance (SSD)*	Minimum stopping distance before colliding
	Velocity Variation	Standard deviation of velocity
	Hard Acceleration or Deceleration	a > 0.2 g a < -0.2 g
	Acceleration and Deceleration Variation	Standard deviation of acceleration or Deceleration

Figure 3 : Stopping Sight Distance*

Mathematical Approach

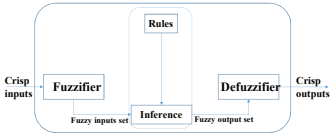


Figure4. Fuzzy rule-based approach

DI: SSD- Remaining Distance

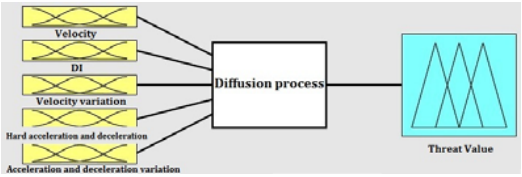
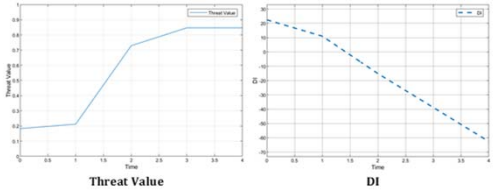


Figure 5: Matlab Structure of the Proposed Threat Analysis System

Analysis Results

Table 1: Simulated Scenario of an Approaching Vehicle

Time of detection(s)	Velocity (km/h)	Distance (m)
0	80	120
1	75	100
2	78	79
3	79	57
4	80	35



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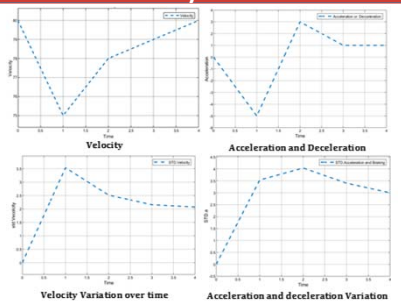

Figure 6: Threat value and 5 indicators real time

Conclusion and Recommendations

- Analyzing the variation of driver's behavior by using data fusion helps us generate threat value.
- By knowing threat value, we warn first responders if a driver is threat for him/her.
- Designing this system can improve safety of first responders, their situational awareness, and give them quantitative and qualitative information about the area.
- Future studies can work on considering environmental and vehicle characteristics factors in data fusion process.

Acknowledgement

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