# Advancing Crash Investigation with Connected and Automated Vehicle Data

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Introduction and Problem

- Connected and Automated Vehicles (CAVs) are rapidly diffusing through the transportation system
- This study seeks to leverage newly available CAV data to improve crash investigation procedures and obtain input from stakeholders, especially law enforcement

- PROJECT GOALS:
    - Enhance existing event data recorder elements by adding new data available in connected and automated vehicles through sensors
    - Analyze detail and accuracy of sensors in CAVs to assist with more comprehensive crash investigations in the future
    - Explore law enforcement involvement in the design of the current EDR retrieval process and their knowledge about using ADS data.
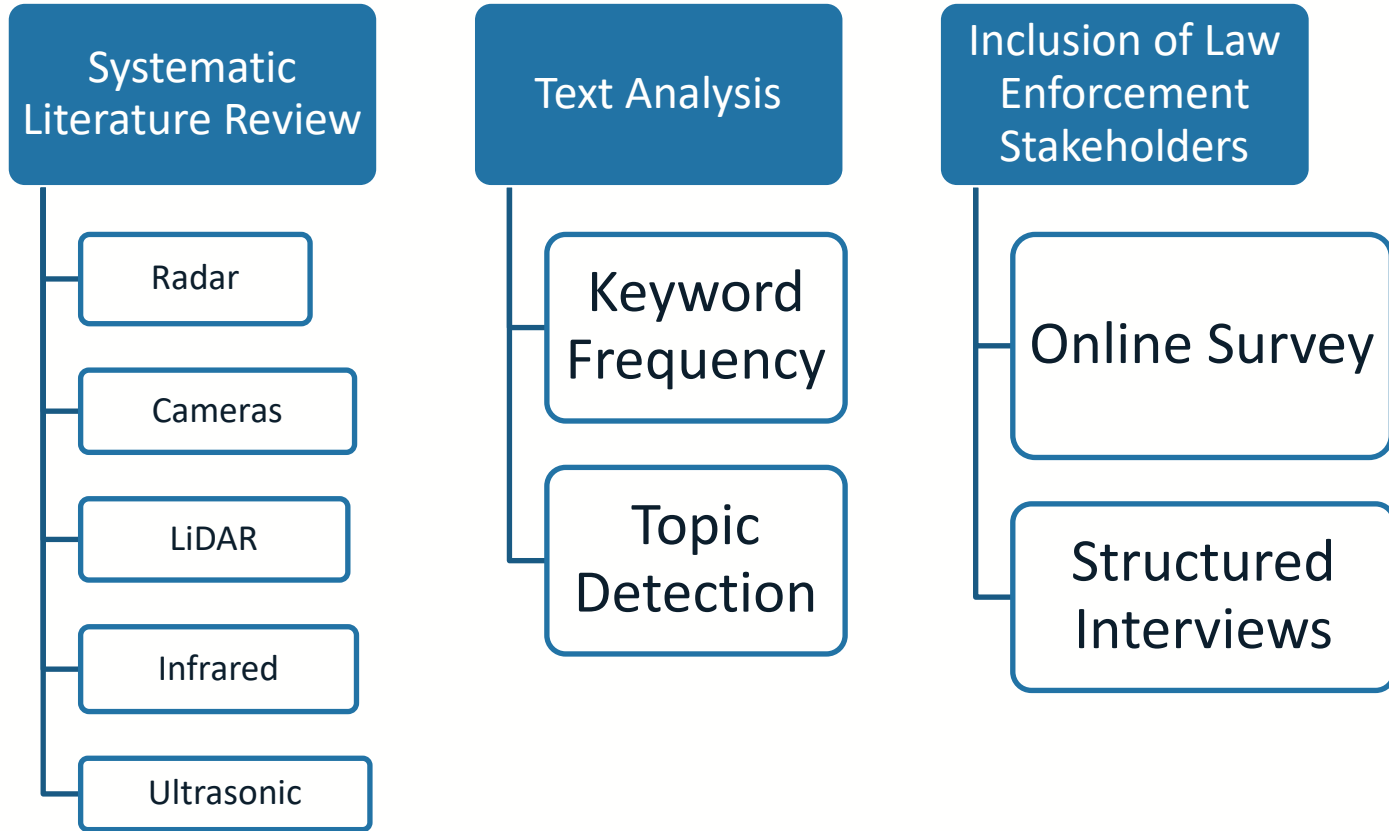
Sensor Capabilities & Limitations-Literature synthesis

Type of Sensor	Sensor	Robust against weather?	Work at night?	Robust against clothing color/type?	Vulnerable to Cyber Attack	Max. Detection Distance (m)
Internal Sensing	GPS	Yes	Yes	N/A	Yes	N/A
Communication	OBU	Yes	Yes	N/A	Yes	N/A
Environmental Sensing	US	Yes	Yes	No	No	Line of Sight
	IR	No (high temps)	Yes	Yes	No	20
	LiDAR	Yes (except fog)	Yes (Very Good)	Yes	No	300
	Radar	Yes	Yes (Very Good)	Yes	No	160
	Camera	No	Yes (Limited)	Yes	No	Line of Sight

LiDAR is the most robust environmental sensor based on the identified limitations

Text Analysis of Systematic Literature Review Results

NO	TOPIC	KEYWORDS	COHERENCE (EIGENVALUE)	FREQUENCY (OCCURRENCES OF KEYWORDS WITHIN TOPIC)	% CASES (% OF CASES IN WHICH THIS TOPIC APPEARS)
1	Security challenges	ATTACKS; THREATS; SECURITY; MALWARE; MALICIOUS; MALWARE ATTACK; SECURITY THREATS; …	0.505	655	84.31%
2	Sensor coverage	ANTENNA; DOPPLER; AMPLITUDE; FREQUENCY; RANGE; PULSES; PHASE; RECEIVE ANTENNA; RANGE FREQUENCY; OVERLAPPING RANGE; STAGE DOPPLER; SUGGESTED SPEED RANGE; RANGE SPECTRUM; PROCESSING TIME; …	0.465	571	80.39%
3	Monitoring Driver	SLEEP; DISTRACTED; VIGILANCE; REACTION; FATIGUED; WARNINGS; CONFLICT; REACTION TIME; SLEEP DEPRIVED; REACTION TIMES; DIMINISHED VIGILANCE; SLEEP DEPRIVATION; …	0.439	437	19.61%
4	Steering control and movements	LATERAL; STEERING; CURVATURE; GPS; WHEEL; STEERING WHEEL; LATERAL DISPLACEMENT; LATERAL ACCELERATION; …	0.429	786	84.31%
5	LIDAR	LIDAR; LASER; SCANNING; ENVIRONMENT; BEAMS; RESOLUTION; RANGE; SENSING; DETECTION; DETECTION AND RANGING;	0.406	1485	94.12%
6	Adverse Weather	ADVERSE; ADVERSE WEATHER; SURFACE CONDITION; DAYLIGHT TIME; WEATHER CONDITION; …	0.391	497	68.63%
7	Object Detection	PEDESTRIANS; VISION; PEDESTRIAN; FRAMES; DETECTION; CAMERA; TRACKING; OBJECTS; SCENE; HUMAN; FRAME; RECOGNITION; PIXELS; MOTION; RADAR; HEAD; VIDEO; BOUNDING BOXES; PEDESTRIAN DETECTION; …	0.360	1166	88.24%

Survey & Interview Results

- Thinking of the future of collision investigation, what are the top three pieces of information (that are not available today) you would most like to get from a vehicle automatically after a collision?
  - 17% - Video/image data
  - 12% - Vehicle reaction time/performance
  - 10% - Speed
  - 10% - Driver/passenger video
- What do you like most about the current process of using EDRs for collision investigation?
  - Abundant information & helpful data (100%)
- What could be improved about the current process of using EDRs for collision investigation?
  - Universal cables/single system (40%)

Limitations

There was a limited survey response (16 Participants)

Questions included in the survey were exploratory and open-ended

Not all relevant articles were extracted into the text analysis software

An effort was made to have numerous sources for each sensor type, but there could exist selection bias in the limited selection of sensors.

Conclusions and Recommendations

Survey

- Survey of law enforcement confirms the desire & need for data from LiDAR and cameras, along with communications information, i.e., basic safety messages, to improve crash investigations
- Law enforcement officers acknowledged the power of information that can be gathered from an EDR; the desire for a universal cable for all EDRs was confirmed

Systematic Literature Review

- Literature on CAV sensors shows that range, pedestrian detection, and steering control are important issues with regards sensor capabilities
- The recommended comprehensive environmental sensor (comprised of the combination of camera and LiDAR technologies) can provide a complete and user-friendly depiction of the environment both around and within the vehicle

Thank You for Your Time!