

CAN-MIRGU: A Comprehensive CAN Bus Attack Dataset from Moving Vehicles for Intrusion Detection System Evaluation

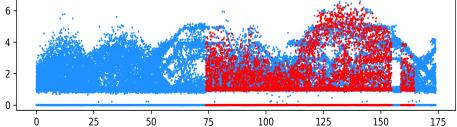
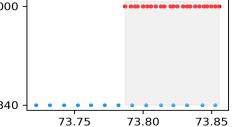
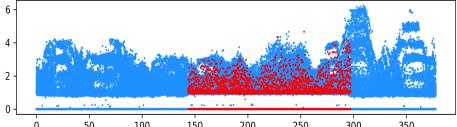
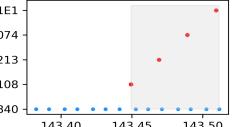
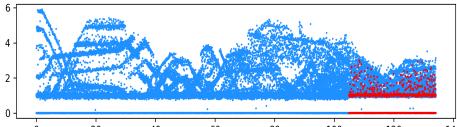
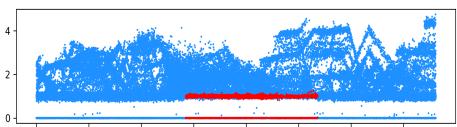
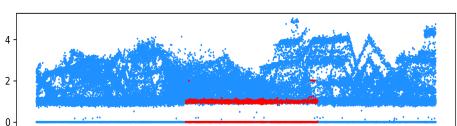
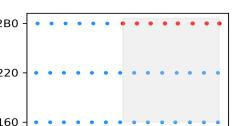
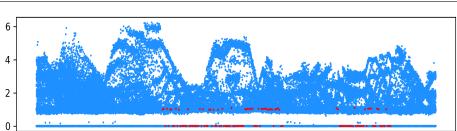
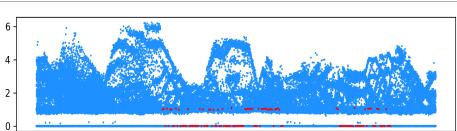
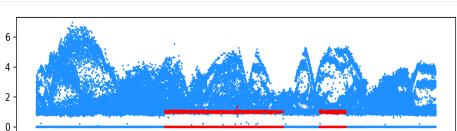
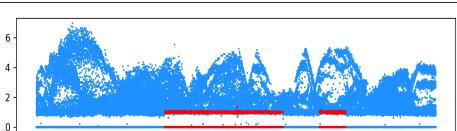
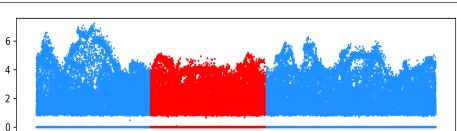
Attack	Observations	Message Timing	Targeted ID Message Timing
DoS 000#FFFFFFFFFFFFFFFFFF 153.704584 Injecting every 0.02s	No visible changes.		
Fuzzing random IDs XXX#XXXXXXXXXXXXXX 153.704584 Injecting every 0.02s	Few warning lights on the dashboard and occasional warning sounds.		
Fuzzing valid IDs XXX#XXXXXXXXXXXXXX 134.016241 Injecting every 0.02s	'Check FCA (Forward Coll. Avoidance Assist)' warning message, parking brake, and ABS indicators on the dashboard. 'Harness Relay Malfunction' warning message on the lane detection display and continuous warning sounds.		
Steering angle 2B0#XXAAXXXXXX 190.264094 Flam	'Check FCA(Forward Coll Avoidance Assist)' warning message on the dashboard and continuous warning sounds.		
Steering angle masquerade 2B0#XXAAXXXXXX 190.264094 Masquerade	Synthetic attack. It is likely to have a similar observation to the steering angle real attack.		
Break and fog light 07F#XXC3XXXXXXXXXXXX 266.008802 Flam	'Check brake light' and 'Check fog light' warning messages on the dashboard and continuous warning sounds.		
Break and fog light masquerade 07F#XXC3XXXXXXXXXXXX 266.008802 Flam	Synthetic attack. It is likely to have a similar observation to the break and fog light real attack.		
Break warning 160#02AAXXXXXXXXXXXX 266.008802 Flam	'Stop vehicle and check breaks' warning message on the dashboard and continuous warning sounds.		
Break warning masquerade 160#02AAXXXXXXXXXXXX 266.008802 Masquerade	Simulated attack. It is expected to have a comparable impact to the brake warning attack.		
ID 160 suspension 160#XXXXXXXXXXXXXXX 314.518042 Suspension	Simulated attack.		

TABLE I: Description of injection attacks. **Attacks:** This column provides information on the attack name, injected ID and payload, attack duration in seconds, and attack technique. **Message Timing:** The subplots display inter-message arrival time between all messages, where the x-axis represents time in seconds and the y-axis represents inter-message arrival time in milliseconds (ms). **Blue dots** and **red dots** indicate benign and attack frames, respectively. **Targeted ID Message Timing:** The subplots represent the transmission of frames for the injected ID near the attack start. The attack area is shaded. The x-axis represents the inter-arrival time for the injected ID, and the y-axis represents CAN IDs, using two same frequency CAN ID (**blue dots**) for comparison. For DoS and fuzzing random IDs attacks, where no particular ID was targeted, the same ID (340) is used for the comparison.

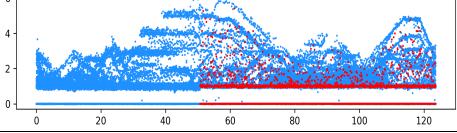
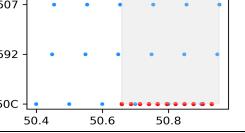
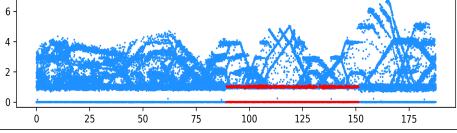
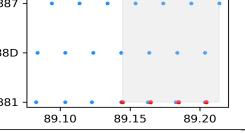
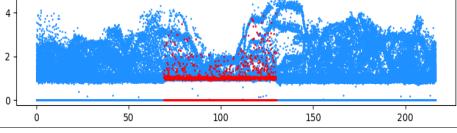
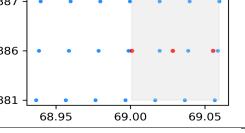
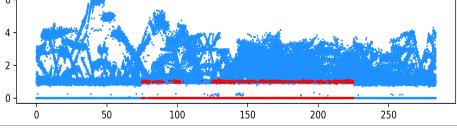
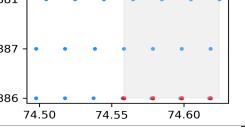
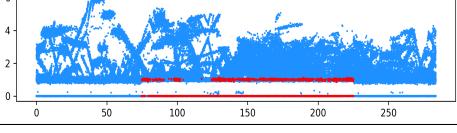
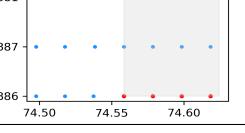
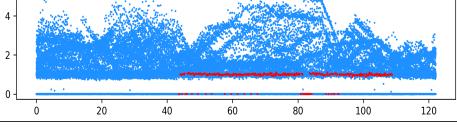
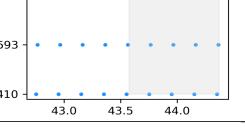
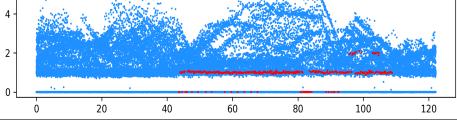
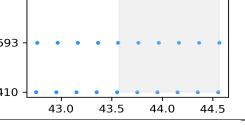
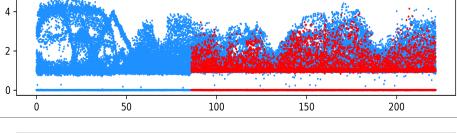
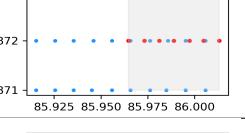
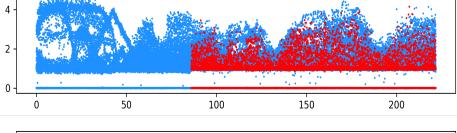
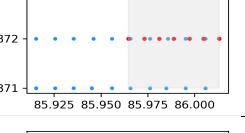
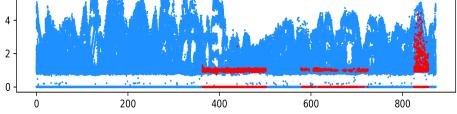
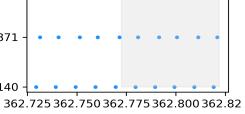
Attack	Observations	Message Timing	Targeted ID Message Timing
Drive mode changing 50C#FF05FFFF24FFFFFFE0 123.605818 Injecting every 0.02s	Continuously switching between normal, sport, eco and eco+ driving modes for a few seconds and stabled at eco+.		
Power steering 381#FFB73FXXXXXX 187.484292 Flam	'Check motor-driven power steering' warning message on the dashboard, slightly less control of the steering wheel.		
Max speedometer 386#FFFFFFFFFFFFFFF 216.432840 Injecting every 0.02s	Speedometer jumps to 159 mph while driving at 30 mph		
Min speedometer 1 386#FF027002F9821D42 283.422522 Flam	Speedometer jumps to 15 mph while driving at 30 mph		
Min speedometer masquerade 386#FF027002F9821D42 283.422522 Flam	Simulated attack. It is expected to have a comparable impact to the Min speedometer 1 attack.		
Wiper warning 559#XXXXXCXXXXXXX 122.107031 Flam	Set the front wiper speed to 2 on the dashboard. No physical movement of the wiper.		
Wiper warning masquerade 559#XXXXXCXXXXXXX 122.107031 Masquerade	Simulated attack. It is expected to have a comparable impact to the wiper warning attack.		
Gear shifter attack 1 372#000001000000AA05 221.688076 Injecting every 0.001s	'Shifting not possible due to overheating' warning message, Steering wheel becomes stiffer.		
Gear shifter attack 2 372#000001000000AA05 208.340552 Injecting every 0.001s	'Shifting not possible due to overheating' warning message. Steering wheel became too loose.		
Multiple attacks 1 372#XXFFXXXXXXXXXXXX 559#XXXXCXXXXXXX 386#00000000F982FFFF 872.579076 Flam and Injecting every 0.02s	Changed driving mode into 2WD certification mode for ID 372 attack, set the front wiper speed to 2 on the dashboard for ID 559 attack, speedometer jumps to 19 mph while driving at 30 mph.		

TABLE II: Description of attacks

Attack	Observations	Message Timing	Targeted ID Message Timing
Steering angle replay 2B0#0700000755 243.840814 Flam	No visible changes		
FCA warning attack 251#008DXXXXXXXXXXXXXX 298.643430 Flam	'Check brake light' and 'Check fog light' warning messages on the dashboard and continuous warning sounds		
Min speedometer 2 386#0100B4821783FCC2 300.926023 Flam	Speedometer jumps to 13 mph while driving at 30 mph		
Min speedometer 3 386#FF027002F9821D42 146.289314 Injecting every 0.02s	speedometer varies between 21-27 mph while driving at 30 mph		
EMS 371#371FXXXXXX2BXXXX 166.409611 Flam	No visible changes		
EMS replay long 371#2E1E000000000000 1058.974900 Flam	No visible changes		
Parking brake 394#XXXXXXXXXXXXAAXX 76.243699 Flam	Warning sounds		
Door open warning 541#03114100000A0045 209.072355 Injecting every 0.001s	Front and rear door open warning message on the dashboard and warning sounds		
Fuzzing valid IDs and DoS XXX#FFFFFFFFFFFFFF 232.154914 Injecting every 0.02s	No changes during DoS, Warning messages and sounds including driving mode changes during valid IDs fuzzing		
Reverse speedometer and fuzzing 386#0100B4821783FCC2 XXX#FFFFFF00FFFFFF 92.542629 Flam and Injecting every 0.02s	Speedometer jumps to 13 mph while driving at 5 mph for speedometer attack, Change driving mode into sport for fuzzing attack		

TABLE III: Description of attacks

Attack	Observations	Message Timing	Targeted ID Message Timing
Multiple attacks 2 251#XXXXXXXXXXXXXX 07F#XXXXXXXXXXXXXX 593#01XXXXXXXXXX 160#02AAXXXXXXXXXX XXX#FFFFFFFFFFFFFF XXX#FFFFFF00FFFFF 1085.432364 Flam and Injecting every 0.02s	'Check FCA(Forward Coll Avoidance Assist)' warning message and sound for ID 0x251, 'Check break light' and 'Check fog light' warning messages and sounds for ID 0x07F, 'Check tyre pressure monitoring system' warning message and sound for ID 0x593, 'Stop vehicle and check breaks' warning message and sound for ID 0x160, Different warning messages and sounds including drive mode change for Fuzzing random IDs and Fuzzing valid IDs attacks		
ID 371 suspension 371#XXXXXXXXXXXXXX 314.692548 Suspension	Simulated attack.		
ID 386 suspension 386#XXXXXXXXXXXXXX 314.516615 Suspension	Simulated attack.		
ID 541 suspension 541#XXXXXXXXXXXXXX 313.716066 Suspension	Simulated attack.		
ID 07F suspension 07F#XXXXXXXXXXXXXX 314.360475 Suspension	Simulated attack.		

TABLE IV: Description of attacks