🚗 Braking Dynamics Simulator

This interactive simulator allows users to compare the stopping performance and safety margins of a human-driven vehicle against an autonomous (AI) system under various road conditions and driver states.

Key Features

- **Dual Mode Comparison:** Switch instantly between Human Driver and Autonomous AI modes.
- **Safety Technology Intervention:** Simulate the impact of modern safety features like Automatic Emergency Braking (AEB) and Emergency Brake Assist (EBA).
- **Real-time Analysis:** Visual simulation, key metrics (reaction distance, braking distance, total time), and a dynamic Velocity vs. Time graph provide instant feedback on physics inputs.

Simulation Modes

Mode	Description	Key Physics
Human Driver	Simulates driver response based on user-defined Reaction Time and Deceleration. Allows modeling impairment.	User-Controlled t_{react} and Deceleration
Autonomous AI	Simulates optimized braking with minimal latency (0.05s) and maximum safe deceleration, including an **Optimal Coast** feature to brake precisely at the required point.	System-Optimized t_{react} and Deceleration

Human Driver Modifiers

Modifier	Effect	Constraints
Impaired Driver	Enforces a minimum reaction time of **2.50s** and reduces the effective deceleration by 20%.	Allows customization of reaction time above the 2.50s minimum.
Modern Safety Tech	Activates AEB/EBA intervention, overriding human input only if a collision is imminent. The system applies higher deceleration ($a \times 1.3$) with minimal reaction delay (0.1s).	Only intervenes to prevent a predicted collision.

Core Inputs

Variable	Unit	Function
Initial Velocity (u)	km/h	The starting speed of the vehicle.
Reaction Time (t_{react})	s	The time delay before brakes are applied (human input only). **Range: 0.1s to 10.0s.**

Deceleration (a)	$\mathrm{m/s^2}$	The maximum braking force applied to the wheels. (Higher values simulate better tire grip/road condition).
Target Separation (s)	m	The initial distance to the obstacle (boy).

Stopping Distance Formula:

$$d_{total} = d_{react} + d_{brake}$$

$$d_{react} = u \times t_{react}$$

$$d_{brake} = \frac{u^2}{2a}$$

Where u is velocity in $\mathrm{m/s}$ and a is deceleration in $\mathrm{m/s^2}$.