CPWC2026-0040 · THE 14TH CLOUD PROGRAMMING WORLD CUP

# GISELLE

## Pedestrian-Aware Emergency Braking for Low-Friction Settlement Roads

*When humanity's settlements get streets, their vehicles must learn to stop again.*

**5.2×**

longer braking distance
on lunar-like roads (μ = 0.17)

measured in UC-win/Road · 8.2 m → 42.7 m
@ ~44 km/h

UC-win/Road 19 · YOLO11 transfer learning · Stereo vision · PWM brake control

INTRODUCTION

# Settlements are becoming towns.

Lunar and Martian outposts are no longer single habitats — they are growing into settlements with roads, traffic, and people who live there.

Every settlement street brings an old problem to a new world: vehicles and pedestrians sharing the same road — this time on regolith, at a fraction of Earth's road friction.

**ADAS was tuned for asphalt.** Every braking assumption inside today's driver-assistance stack quietly presumes μ ≈ 1.0. On settlement roads, that assumption breaks.

### Permanent settlements

Moon/Mars development plans now include residential zones, logistics routes, and daily surface traffic.

### Low-friction roads

Regolith-covered surfaces behave like μ ≈ 0.17 — braking behaves like ice, all the time.

### Earth-tuned ADAS fails

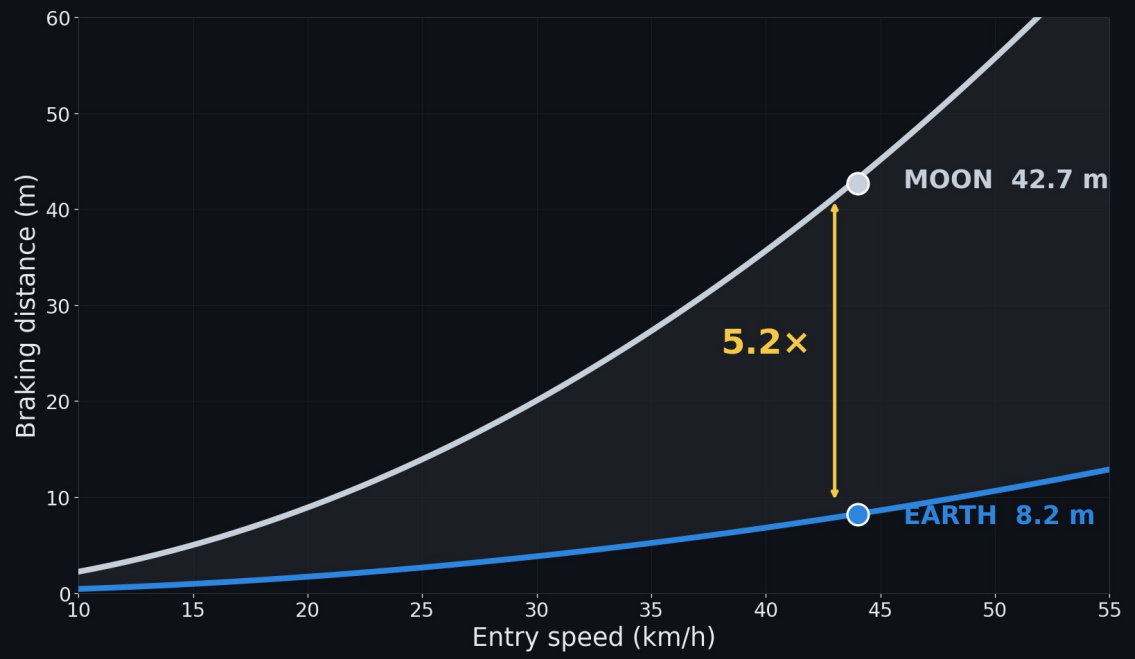
A braking profile that is safe on Earth guarantees a collision at the same speed on settlement roads.

THE PROBLEM

# Same speed. Same brake. Five times the distance.

| | EARTH<br>μ = 1.0 | MOON<br>μ = 0.17 | × |
|---|---|---|---|
| Entry speed | 43.9 km/h | 43.7 km/h | |
| **Braking distance** | **8.2 m** | **42.7 m** | **5.2x** |
| Braking time | 1.4 s | 7.0 s | **5.0x** |
| Deceleration | 9.06 m/s² | 1.73 m/s² | |

Identical entry speed (~44 km/h), identical brake input — measured in UC-win/Road.




The 5.2× gap holds across every entry speed — it is physics, not an edge case.

**A pedestrian a driver could always stop for on Earth is a collision on the Moon.**

WHY SIMULATOR-BASED?

# The one test track nobody can build yet.

## Untestable in reality

Low-gravity, low-μ pedestrian emergencies cannot be rehearsed on Earth — and must never be rehearsed with real people. Simulation is the only ethical test track.

## Full physics control

UC-win/Road lets us set surface friction per road, script child / adult crossings at exact speeds, and replay the identical emergency hundreds of times.

## Ground truth built in

The simulator knows every true position. Our perception is cross-verified against it every frame — false positives are caught before they can brake the vehicle.

*Validated on UC-win/Road Ver.19 — the same platform, physics, and telemetry used for every number in this deck.*

SYSTEM PIPELINE

# Detect → Measure → Verify → Brake



## DETECT

detect.py

YOLO11, transfer-trained on our own settlement footage. Distinguishes adult vs child — because they need different stopping margins.

→



## MEASURE

stereo.py

Twin virtual cameras (B = 0.5 m). Disparity → distance; tracked over time → crossing & approach speed. No maps, no beacons.

→



## VERIFY

detect.py · fusion

Every detection is cross-checked against telemetry by azimuth and range. Tires and poles never reach the brake controller.

→



## BRAKE

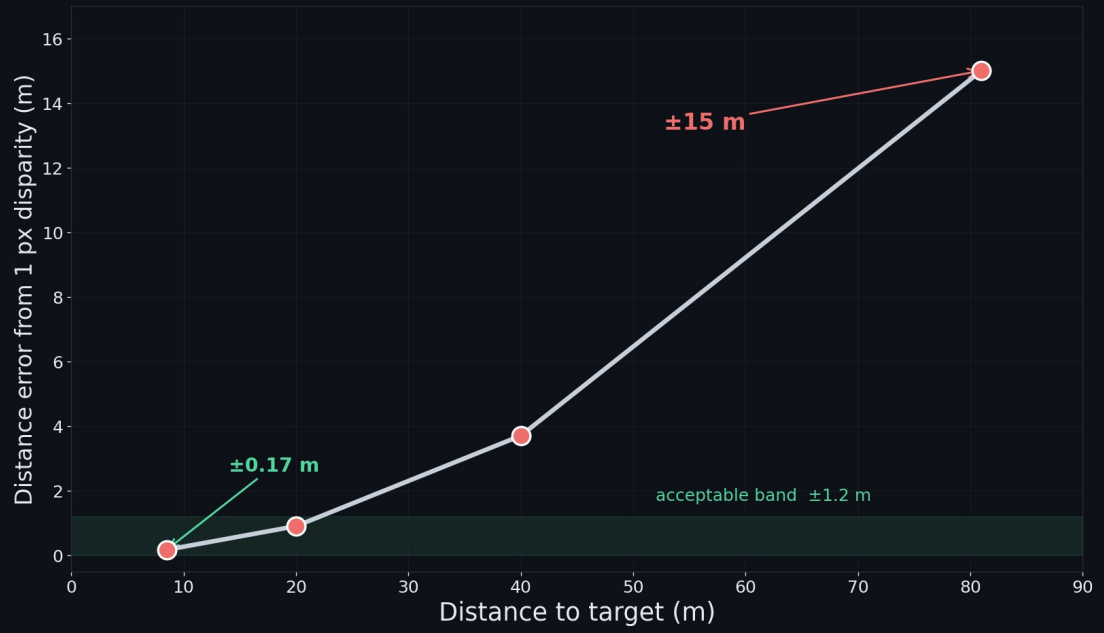
brake.py

PWM parking-brake actuation with PI duty control. Class-aware stop line: 8 m before an adult, 10 m before a child.

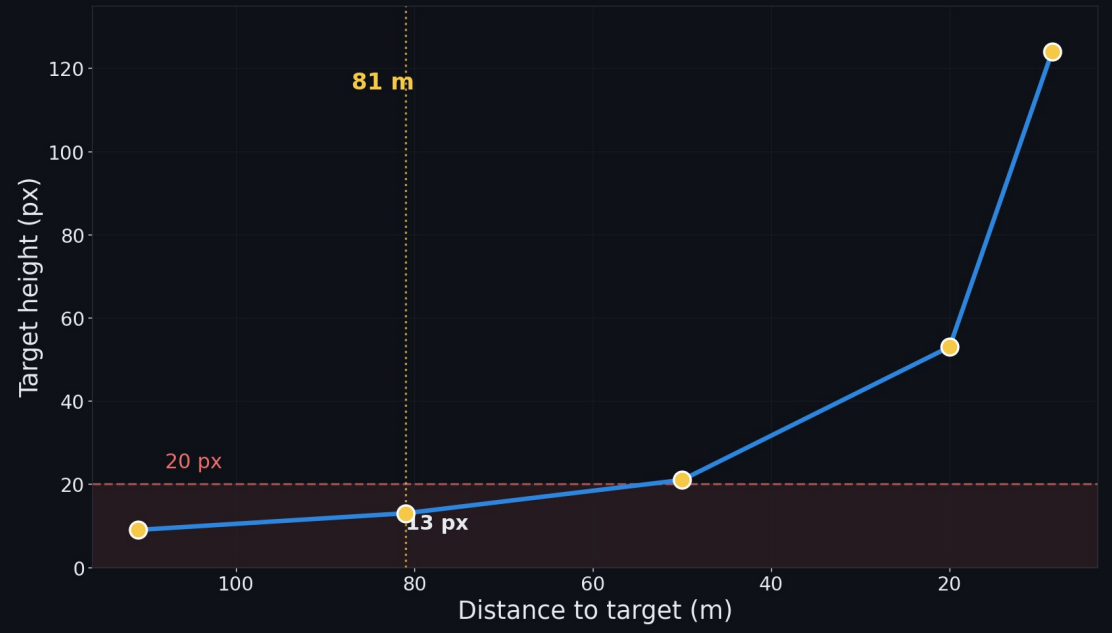
Two independent processes share one UC-win/Road access layer (common.py) — perception can crash, restart, or lag without ever taking the brake loop down.

PERCEPTION — STEREO VISION + YOLO

# Near, trust the camera. Far, verify everything.




Stereo ranging error from 1 px of disparity: ±0.17 m at 9 m — but ±15 m at 81 m. Precision belongs to the near field.

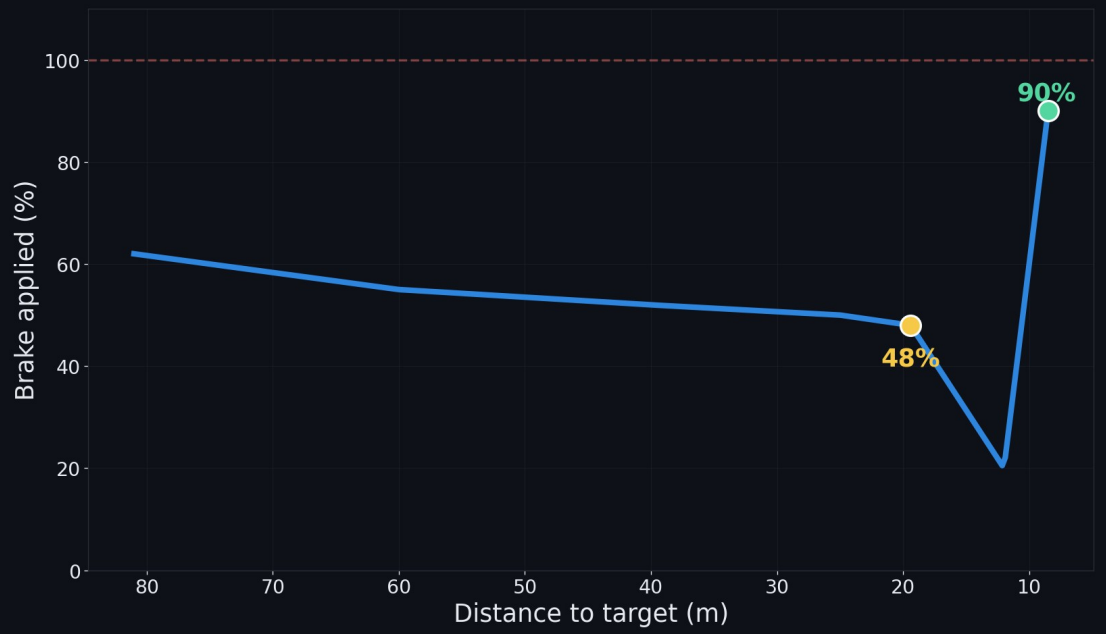



A pedestrian at 81 m is 13 px tall — below the 20 px detection floor. Long range needs more than one sensor.

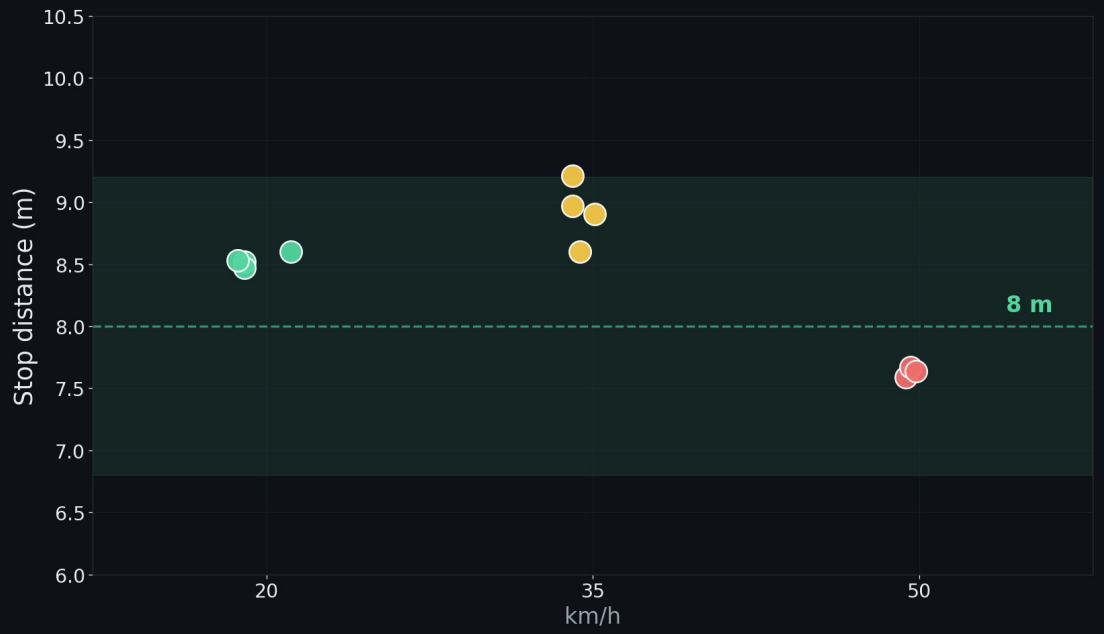
**So GISELLE divides the labor: stereo vision owns the near field, telemetry cross-verification owns the far field — and only verified targets may trigger a brake.**

CONTROL — BRAKING ON ICE, BY DESIGN

# One brake profile, repeatable to the meter.




Distance-scheduled braking: ~48 % holds the deceleration plan, a 90 % finisher plants the stop — PWM parking-brake pulses with PI duty correction.

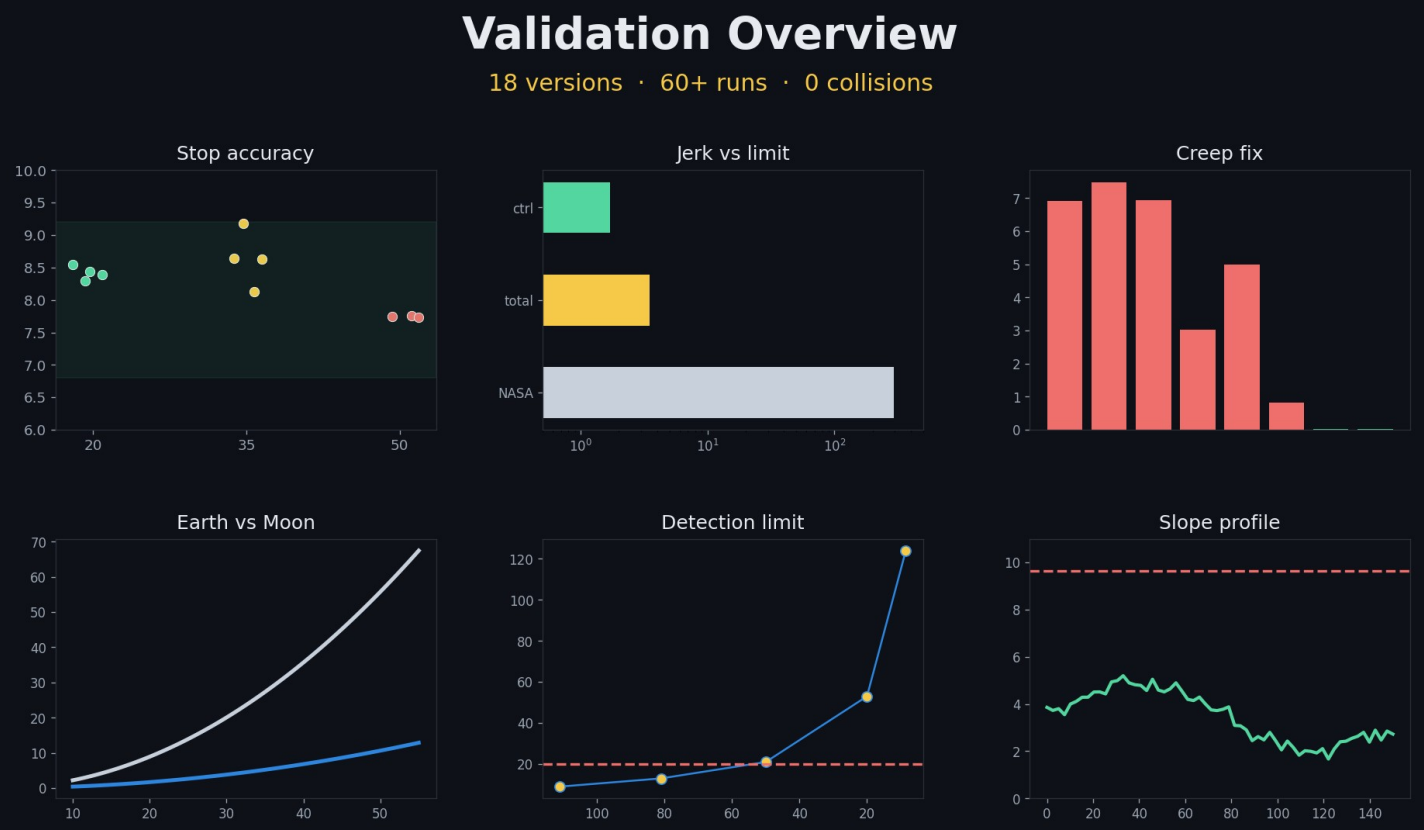



11 emergency runs at 20 / 35 / 50 km/h — every stop lands inside ±1.2 m of the 8 m line, on μ = 0.17.

**Children get 10 m. Adults get 8 m. The margin is a perception decision, not a hard-coded constant.**

VALIDATION & SAFETY

# Engineered until it stopped surprising us.




**18 / 60+ / 0**

versions · runs · collisions

**10.1 % · 1.2 %**

of NASA-STD deceleration & jerk limits used

**6.92 m → 0.02 m**

post-stop creep, root-caused across 8 versions

**Passengers feel a controlled 1.99 m/s² glide — firm enough to stop in time, gentle enough to be a ride, not an event.**

FUTURE DEVELOPMENT

# From one vehicle stopping to a settlement that never hits anyone.

### V2V hazard relay

Our prototyped rover-to-rover link relays a detected pedestrian to vehicles that cannot see them yet — around curves, through dust, in convoy.

### Perception hardening

Second-stage YOLO training: close-range children, negative mining on look-alikes, and dust / lighting augmentation for regolith conditions.

### Digital-twin friction maps

Live μ estimation fed back into a settlement-wide digital twin, so every vehicle inherits every other vehicle's road knowledge.

# THANK YOU

*GISELLE — stopping for people, wherever roads go.*

Team GISELLE · CPWC2026-0040