

CSC 144V: Autonomous Vehicles

Lecture 1.2

AV Sensors and V2X Exercises Solution

Department of Computer Science,
Hofstra University

Exercise: Sensor data rates

- A **128-channel lidar** produces 1,800 azimuth measurements per channel per revolution and rotates at 10 Hz; each point takes 16 bytes.
- A **camera** has 1920×1080 pixels, 3 bytes per pixel (uncompressed RGB) and runs at 30 frames per second.
- Use $1 \text{ MB} = 10^6 \text{ bytes}$.

(i) Data rate of the lidar in MB/s?

(ii) Data rate of one camera in MB/s?

(iii) An AV carries 8 such cameras and 1 such lidar: total rate in GB/s, and raw TB per hour of driving?

Item	Data rate
Lidar	
1 camera	
8 cameras + 1 lidar	
1 hour of driving	

Exercise Solution: Sensor data rates

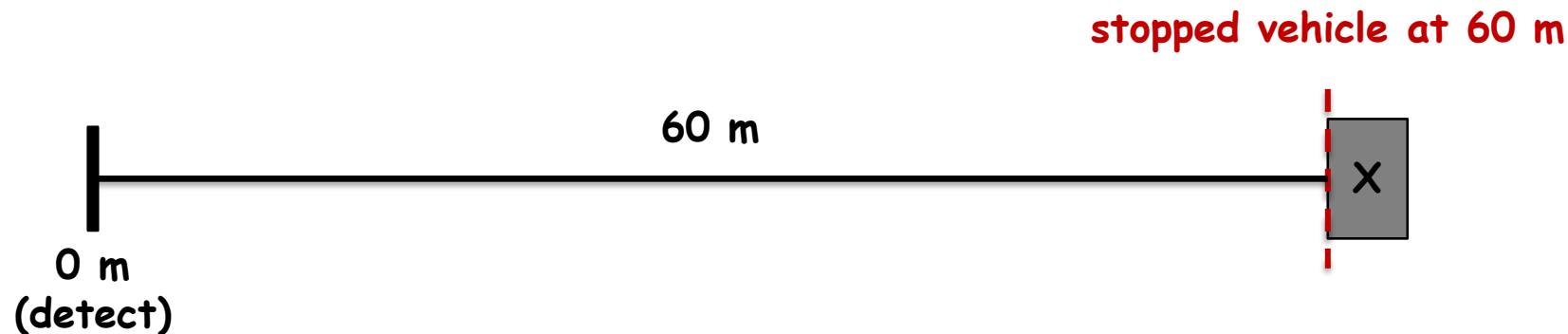
- **Lidar:** $128 \times 1,800 \times 10 = 2,304,000$ points/s; $\times 16$
B = 36,864,000 B/s
- **Camera:** $1920 \times 1080 \times 3$ B = 6,220,800 B per
frame; $\times 30$ fps = 186,624,000 B/s
- **Total:** $8 \times 186.6 + 36.9 \approx 1,530$ MB/s
- **Per hour:** 1.53 GB/s $\times 3,600$ s $\approx 5.5 \times 10^{12}$ B
- One raw camera stream is about 5× the lidar
stream: **cameras dominate** the raw data volume.

Item	Data rate
Lidar	36.9 MB/s
1 camera	186.6 MB/s
8 cameras + 1 lidar	1.53 GB/s
1 hour of driving	≈ 5.5 TB

Exercise: Blind curve and V2X

A disabled vehicle is stopped behind a **blind curve**. Your AV drives at 30 m/s (108 km/h). Its onboard sensors can first detect the stopped vehicle at a distance of **60 m**. The total latency from detection to the start of braking is **0.2 s**; the AV then brakes with a constant deceleration of **6 m/s²**.

- (i) Compute the total stopping distance.
- (ii) Can the AV stop in time using onboard sensors only? Name one V2X communication that could help, and explain why in one sentence.



Exercise Solution: Blind curve and V2X

- Distance during the latency: $30 \times 0.2 = 6 \text{ m}$; braking distance: $v^2/(2a) = 30^2/(2 \times 6) = 75 \text{ m}$; total = $6 + 75 = 81 \text{ m}$.
- $81 \text{ m} > 60 \text{ m}$, so **No**. After the 6 m latency distance only 54 m remain, and the AV still hits the vehicle at $v = \sqrt{30^2 - 2 \times 6 \times 54} = \sqrt{252} \approx 15.9 \text{ m/s} \approx 57 \text{ km/h}$.
- V2V** warning from the disabled vehicle (DSRC or C-V2X direct): low latency, no line of sight needed, range of several hundred metres, so the warning arrives well before 81 m.

