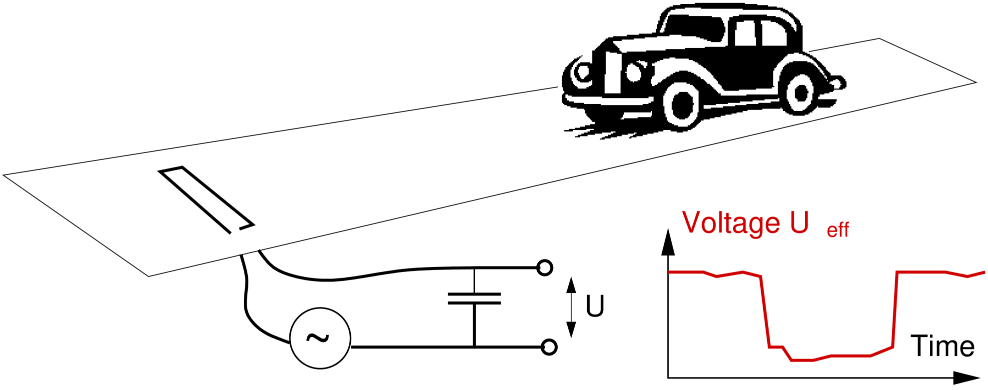
Lecture 2: Stationary Detector Data

- 2.1. Stationary Detector Data (SDD) and How to Obtain Them
- 2.2. Single-Vehicle Data
- 2.3. Aggregated Data

2.1. Stationary Detector Data (SDD) and How to Obtain Them

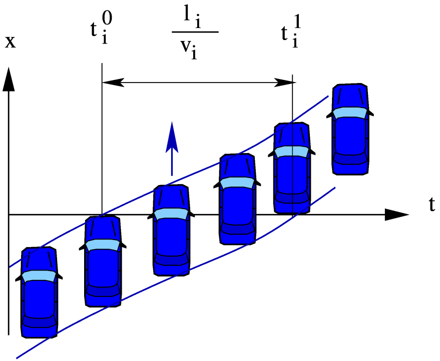


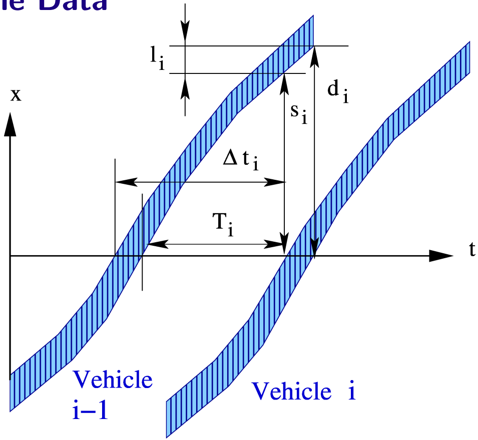
- Vehicle drives over a loop detector ⇒ inductance of the loop increased upon driving over it ⇒ circuit gets out of tune.
- Other means: pneumatic tubes, IR light barriers, radar/lidar

? Discuss the advantages/disadvantages of induction loop detectors wrt. other sensors.

Loop/double loop detectors are everywhere ...

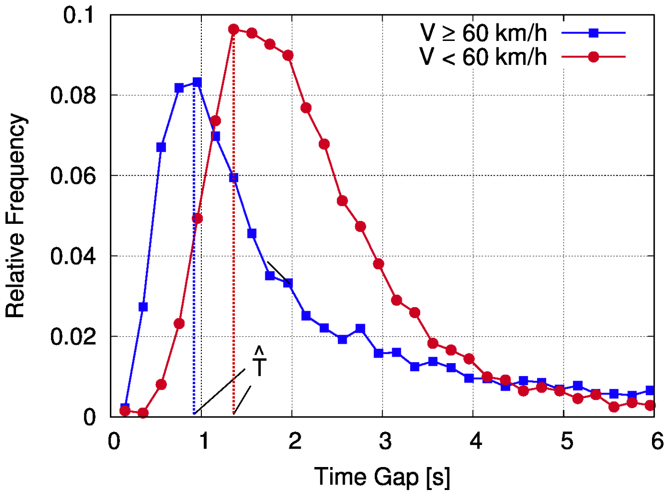
2.2. Single-Vehicle Data





- **Occupancy time**: $t_i^1 - t_i^0$ (single loops OK)
- **(Time) headway**: $\Delta t_i = t_i^0 - t_{i-1}^0$ (single loops OK)
- **Time gap**: $T_i = t_i^0 - t_{i-1}^1 = \Delta t_i - \frac{v_{i-1}}{l_{i-1}}$ (single loops OK)
- Vehicle speed: $v_i = \frac{(t_i^0)_{\text{loop2}} - (t_i^0)_{\text{loop1}}}{\Delta x_{\text{loops}}}$
- Vehicle length: $l_i = v_i(t_i^1 - t_i^0) \Rightarrow$ vehicle type
- **Distance headway**: $d_i = v_{i-1}\Delta t_i$
- **(Distance) gap**: $s_i = d_i - l_{i-1}$

Application: Density functions of time gap distributions



- ? Compare with the German driving rule "keep a gap of at least half the speedometer reading"
- ? Compare with the US rule "keep an additional vehicle length distance per 5 mph"

Distance rules

Keep a gap of at least half the speedometer reading:
Units: Germany → gap in meter, speedometer reading in km/h

$$\frac{s}{1\,\mathrm{m}} \geq \frac{1}{2}\frac{v}{\mathrm{km/h}}$$

$$T = \frac{s}{v} = \frac{1}{2}\frac{\mathrm{m}}{\mathrm{km/h}}$$

$$= \frac{1}{2}\frac{\mathrm{m}}{\frac{1}{3.6}\mathrm{m/s}}$$

$$= \underline{\underline{1.8\,\mathrm{s}}}$$

Keep an additional vehicle length distance per 5 mph:
Assume a vehicle length of 5 m (US vehicles are big!):

$$T = \frac{\Delta s}{\Delta v}$$

$$= \frac{5\,\mathrm{m}}{5\,\mathrm{mph}}$$

$$= \frac{1\,\mathrm{m}}{\frac{1.6}{3.6}\mathrm{m/s}}$$

$$= \underline{\underline{2.25\,\mathrm{s}}}$$

2.3. Aggregated Data

Most detectors stations *aggregate* the single-vehicle information over fixed **aggregation time intervals Δt** and transmit only the aggregated **macroscopic** data to the traffic control center.

- **Flow** $$Q(x,t) = \frac{\Delta N}{\Delta t} = 1/E\left(\Delta t_i\right)$$
  where the **expectation** $E\left(.\right)$ is just the arithmetic mean over the microscopic data y_i: $E(y_i) = \frac{1}{\Delta t}\sum_{i=i_0}^{i_0+\Delta N-1} y_i$
- **Occupancy** $$\mathcal{O}(x,t) = \frac{\Delta N \;\; E\left(t_i^1 - t_i^0\right)}{\Delta t} = Q(x,t)E\left(t_i^1 - t_i^0\right)$$
- **(Arithmetic mean) Speed** $V(x,t) = E\left(v_i\right)$ (double loops)

Useful but generally not known:

- **Harmonic mean speed** $V_{\mathrm{H}}(x,t) = 1/E\left(1/v_i\right)$
- **Harmonic flow** $Q^*(x,t) = E\left(1/\Delta t_i\right)$

Fundamental Diagram from Traffic-simulation.de