Abstract
Lane changes are an important traffic characteristic, for instance for determining the OD matrix. This paper proposes a method to find lane changes with loop detectors. It is found that the number of lane changes is proportional to the number of straddles (the event where one vehicle is detected by loops in two adjacent lanes simultaneously). The method requires a site-specific calibration (for instance by analysing video images). After calibration, the number of straddling vehicles, measured by loop detectors, gives a probability distribution for the number of lane changes. This gives the average number of lane changes.

1. Measuring straddling
A vehicle can be detected by two loops in adjacent lanes simultaneously. This is called straddling. The magnetic profile of both loops can be compared and thus it can be concluded that it is the same car passing at two loops.

2. Interpretation straddling percentage $p$
- Each lane changer straddles with probability $p$
- Probability to find $s$ straddles from $l$ lane changes:
  \[ P(S = s | L = l) = \binom{l}{s} p^s (1 - p)^{l-s} \]
- $p = \frac{D_{\text{straddling}}}{D_{\text{section}}}$
- Depends on site:
  - Distances detector-lane separation
  - Detector sensitivity

Findings
- No straddling without lane change, no straddling to “wrong side” (e.g., left straddle for right lane change)
- Straddling time per lane change is constant

3. Data set
- M42, near Birmingham, United Kingdom
- Three-lane freeway
- Individual loop detector data
  - Individual passing times
  - Individual speeds
- Straddle flag
- Loops every 100 meters over 1600 meters
- Vehicle re-identification from loop to loop possible, so lane changes are known

4. Calibration
- Goal: find $p$
- Use data set with known straddles and lane changes are known
- Method:
  Maximum likelihood estimator on number of straddles out of number of lane changes

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Paper presented at TRB 2011
the 90th Annual Meeting of the Transportation Research Board
Paper number 11-0109

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Number of Lane Changes Determined by Splashover Effects in Loop Detector Counts
0. Example use: straddles for OD estimation

- All links are equipped with detectors
- No lane change information
- Origin-destination matrix cannot be determined
- Via the proposed method, the number of lane changes from lane 3 to lane 4 or vice versa can be determined
- With this number of lane changes, the OD matrix can be found

5. Method: Recovering lane changes from measured straddles

1) Estimate the distribution of lane changes from the distribution of straddles.
2) For each number of lane changes determine the probability of s straddles obtaining the joint distribution. This is the distribution for the number of lane changes.
3) Take the case for s straddles out of the distribution and normalise.

6. Results

- Accurate reconstruction of the distribution of number of lane changes
- Longer section length than 200 meters will widen distribution
- For average number of lane changes still good

7. Conclusions

The number of straddles is closely correlated with the number of lane changes. Thus, loop detectors can be used to measure lane changes. The method needs a site-specific calibration (for instance with video) and loops need to be reconfigured to record straddles.