Cycling Research

A DISTURBANCE IN THE FORCE (with apologies to George Lucas…)

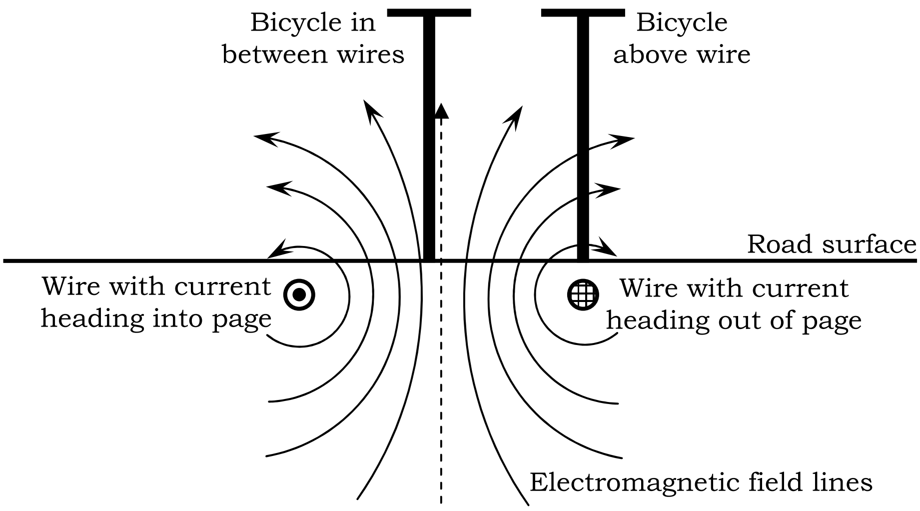
Many cyclists have come across the problem of traffic signals not registering their presence and, in the absence of any other traffic, having to wait forever for the lights to change. So how do traffic signal detectors pick up bicycles and other vehicles? How can they be made to detect cyclists more consistently? And what can cyclists do to help their cause?

The nerve system of most traffic signal detectors are "inductive loops" – conducting wires cut into to the road that detect the presence of metal objects above them. If you look closely at the road (or path) surface approaching an intersection, you should be able to make out the shape of the loops (see picture to the right).

Now a little high-school or college physics is necessary to introduce the principles involved; bear with me… A low current is fed through the wire loops, which in turn produces an electromagnetic field (EMF) that 'orbits' around the wires. If you hold your left hand in a "hitch-hikers pose" (i.e. clenched with thumb out) then, if the current in the wire is travelling in the direction of your thumb, the EMF is circulating in the direction of your other fingers.

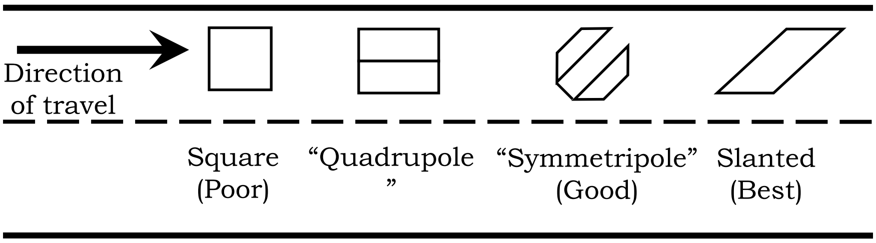
If a conducting object (e.g. metal) passes through these fields then they will cause a disturbance in the EMF around the wire (technically a "change in inductance"). This change can be detected and a vehicle recorded as being present.

To produce this disturbance, the conducting object effectively needs to "slice through" the EMFs. For a bicycle (which is basically a vertical piece of metal), this will happen best when the bike is travelling directly ***along*** a wire (i.e. where the EMFs are mostly horizontal, or perpendicular to the bike). If a bike is in between loop wires then the largely vertical EMFs there will not be greatly affected. The diagram below illustrates these scenarios. Note that crossing a wire *perpendicular* to the direction of travel doesn't affect things much as the EMF will also be parallel to the travel direction and won't get sliced.



For a large wide object like a car, it is not particularly difficult to get some part of the vehicle slicing the EMF and triggering the detector (the larger mass of metal also causes a greater change in inductance).

All this suggests that loop shapes with sections ***parallel*** to the direction of travel (or at least not totally perpendicular) are best for detecting cyclists. Below are some common loop shapes and their relative performance in detecting bicycles. Note that it does depend on where the bike is too; all of these are still capable of detecting cyclists in some parts. To improve detection, it is also desirable to make loops long enough to cover both wheels at once (i.e. ≥ typical bicycle wheelbase of 1.1m).



Signal detectors are usually set to only register changes in inductance above a given threshold. A typical bicycle only results in about a 0.1-0.2% change in inductance. So why not just lower the threshold, so that bicycles are more likely to be detected? The problem is that then other spurious things may also be more likely to be detected, e.g. traffic in an adjacent lane. So it's a fine balance between too much and not enough sensitivity. Because of the varying conditions at each location, trial and error on site is often the best way to get it right.

What about modern racing bikes these days that are made of non-metallic materials? Generally, such bikes still have enough metal on them (chains, gears, etc) to be detected. Interestingly, another potential problem is with mountain bikes, where the fat knobbly tyres lift the bike wheels and frames up another centimetre or so, which also reduces the sensitivity to detection.

In summary, here are some key conclusions and actions:

- Detector loops with lots of bits parallel or slanted to the direction of travel have the best chance of detecting bikes anywhere on them.

- Even if there is no specially shaped or tuned detector, your best chance of triggering it is to ride along the edges of the wire.
- Roading agencies can help this by marking small diamonds along the most sensitive parts of loops (see picture to left)
- If you find places that still don't seem to be picking up bikes, ask your council to adjust the sensitivity of the detectors (threshold is probably too high). Note that the contractor should test this with a *real* bike and not just, say, a toolbox (too much metal!).
- If you're still having trouble getting detected at a site, try laying your bike down lower to the ground over the detector loop.

Some Relevant Reading

- V.Kerdemelidis, 1993. “Electromagnetic Loops in Roads for Vehicle Detection”, *Transit NZ Research Report No. 15* - assesses the merits of various inductive loop shapes.
- R.Leschinski, 1994. “Evaluation of Inductive Loops for Bicycle Detection”. *17th ARRB Conference Proceedings*, Gold Coast, Queensland, Australian Research Board, Victoria, Australia -investigates on the best shapes for bicycle detection.
- A.Macbeth & M.Weeds, 2002. “Evaluation of automatic bicycle counters in New Zealand”, *Transfund NZ Research Report No. 230* - evaluates the use of rubber-tube counters for detecting bicycles.

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