Road Marking Characteristics and Possible Processing Techniques

Lane Marker Characteristics

1. Yellow or white
2. Fixed width (4-6 inches ~ 10-15 cm) [MUTCD sec. 3A.05]
3. On darker background (at least very slightly darker depending on the lighting)
4. Above 3 features create two parallel edges with a dark-bright-dark pattern
5. Minimum length (standard dashed lines are 10 ft ~ 3 meters of marker with 30 ft ~ 9 meter gaps between them) [MUTCD sec. 3A.05]
6. Absolute minimum lane width (spacing between adjacent lane markers) is 8 feet ~ 2.4 meters [MUTCD sec.3B.01], but bike lane markers can be spaced closer.

Stop Line Characteristics

1. White
2. Fixed width (12-24 inches ~ 30-60 cm) [MUTCD sec. 3B.16]
3. Span the entire lane width
4. Perpendicular to the lane markings (if lane markings are present)
5. If dashed lane markings are present, they will connect to solid (not gap) regions – I think. (I can't think of any case where I've seen the opposite.)

Gradient magnitude?

Not perfect because it requires setting a threshold. We want to minimize the number of threshold-type parameters since they need tuning.

Brightness threshold?

Two problems:

1)It's another tunable parameter.

2)It largely eliminates the chance of finding lane markers in shadows unless thresholds are set too low to be helpful.

But, if we use RANSAC to fit the polynomials, it might not be a bad idea to use the brightest pixels as seed pixels since it is unlikely that an entire lane marker will be in shadow.

Color space location?

either – distance from yellow and white – or – better yet angle deviation from [1 1 0] and [1 1 1]. That should be relatively insensitive to brightness.

Problem – the web cam data we have has such poor color fidelity that the lines have green, blue, red, and other colors mixed together.

Other problem – asphalt and pavement are in the [1 1 1] direction with a magnitude just like a white lane marker in a shadow.

~~Orientation-dependent boosting~~

~~(Eliminates the possibility of finding all marks regardless of direction)~~

~~RMS error with template patches~~

~~(Requires a lot of assumptions, processing time, and ad-hoc thresholds. Would be best to avoid)~~

Processing Technique to Exploit the Dark-Bright-Dark Lines Characteristic

Output from steerable filters, Gxx, Gxy, Gyy

Dark-Bright-Dark Lines/Stripes

To have a dark-bright-dark line, we need Gmin<0 and Gmax≈0, so mean(Gmin,Gmax)<0.

Looking at the output of the steerable filters like inertias or stresses, we can apply concepts from Mohr's circle and we know that mean(Gmin,Gmax) = mean(Gxx,Gyy) = ½*Laplacian. So, we can save a division by 2 and just make sure that the Laplacian = Gxx+Gyy < 0. This will require a threshold, which we can probably make relative (like 0.05*min(Laplacian) – could just look in a window when doing this so that hopefully you could still find things in regions of large shadows).

Angle from steerable filter or gradient

Calculate at each location that passes the Laplacian sign test.

Gradient sign change

Just retaining the significantly negative Laplacian pixels does a decent job of keeping just lane markers, but there is some other noise.

Next, at each of the pixels that pass the Laplacian test, get the angle for thetaMin, and then check for sign changes along that direction within a single lane marker width or so.

If we find the sign change, then pick out the zero crossing (maybe by interpolation) and that point gets marked as a potential lane marker center.