Train Positioning and Track Location using Video Odometry

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1. Position Estimation

The RDS video odometer measures forward and ‘sideways’ displacement.

The sideways displacement is related to track curvature. From this information we can estimate the 2D movement of the train. The challenge is to get better estimates of position than we are currently obtaining. One area for investigation is the ‘cant’ of the track, i.e. tracks are slightly banked to improve cornering performance. The motion is therefore not planar as we are currently assuming.

2. Track Location from Curvature

The video odometer measures displacement from a known point. To obtain current position from the odometry, one or more ‘known’ prior points are required. Currently we need an additional input (e.g. GPS location) for this initialisation. However, GPS is not always available (and it does not distinguish between adjacent tracks reliably). As we have an estimate of track curvature for each journey, and the actual track curvature is invariant, it is possible that we can use track curvature ‘signatures’ to determine train position.
The challenge is to determine the extent to which track curvature can be used for ‘positional fixes’. E.g. given a map of the UK rail network, can we efficiently search for curvature matches given the number of different routes through junctions? How far would we need to travel before we can obtain a unique location fix using track curvature?

Also how do we match the real time video odometry data to the curvature map, given the dead reckoning errors inherent in the odometry measurements?

3. **Elimination of pitch (and other) errors**

Our previous study group problem examined the odometry errors resulting from train movement – pitch, yaw and roll.

We are now looking at two possible approaches to tackle the pitch induced error:

- using a camera mounted accelerometer to detect changes in the gravity vector
- using two cameras, one mounted vertically above the other.

Which of these two approaches is likely to give the best results?

To what extent could they address roll and yaw errors?

To what extent could they also be used to estimate changes in camera height (or more specifically changes in the track bed height - eg when the track bed drops when moving over an inspection pit, or raises up at a level crossing).