1. Map Making using GPS
- Maps of roads, railways and waterways can be routinely created and revised nowadays using data from GPS receivers carried along the route. Using differential and other dsp methods, commercial receivers quote positional accuracies in the range 15m to ±0.1m.
- This approach to map making is useful
  - where the area is remote and has sparse detail;
  - where roads etc are temporary; and
  - in populous regions where detailed visual logging of wayside structures is required.

1.1 Current use of video data
- Visual information is often recorded, but then used very crudely (below left). Two cameras point left and right of the moving vehicle (below), and log objects as they pass.
- Disadvantages of current methods:
  - Two cameras/recorders are required.
  - The visual data are all but thrown away.
  - The operator can be surprised by objects passing.

2. Algorithm
- No surprises here — the method is just structure from known motion.
- Choose a point on the object. Track it over images i until it exits the field of view, giving rise to the image measurements:
  \[ x_i = (x, y, f) \]

1.1 The method in this poster
- In our method, we use a single forward facing camera and recover structure from known scene dimensions. Starting from some unknown distance \( z \), we end up with
  \[ x_i = \frac{\text{GPS frame}}{\text{camera}} \]

3.1 Calibration
- The method adopted requires that the camera’s intrinsics and extrinsics be calibrated. Rather than using laboratory techniques, we in this application have used large outdoor structures with known geometry combined with the GPS data.
- For example, measurements were made of the image width and height of a bridge of known scene dimensions. Starting from some unknown distance \( z \), a bridge of width \( W \), the inverse image width \( 1/w \) will vary linearly with distance \( z \) moved forward to give the focal length.

\[ w = \frac{fW}{z} \]

4. Experiments on Single Structures
- Video and GPS data were recorded at 25Hz during a half hour long journey along a railway line through Poole. Each video frame had a VITC time code written at the top of the image, allowing video and GPS data frames to be rematched during offline analysis. The experiments shown here use images sampled at 7Hz.
- We compare the output from the method with the OS coordinate to within errors, which are expected to be a few tens of centimetres.

5.1 800m East of Parkstone Station
- A comparison with the OS map follows.

5.2 Parkstone Station
- As with the first example, only the text has been added by hand. Note that the train is travelling on the left hand, more southerly, track, and this is recovered in the map.

6. Conclusions
- GPS provides convenient method of taking structure from known motion out of the laboratory.
- Modest investment in visual processing has made a significant impact in this task.