Stereo Vision for the Detection of Road Signs in Dusk and Nighttime Traffic Sequences

Simon McLoughlin[1], Ciara Mulvihill[1], Catherine Deegan[1], Stephen Foy[1], Conor Fitzgerald[3], Charles Markham[2]
[1]Informatics and Engineering, Institute of Technology Blanchardstown | [2]Dept. Computer Science, NUI Maynooth |
[3]National Roads Authority

Institute of Technology Blanchardstown

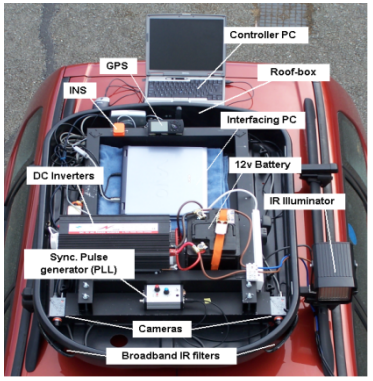
NUI MAYNOOTH
Ollscoil na hÉireann, Má Nuad

• A novel technique based on stereo vision is described for the identification and localisation of traffic signs in dusk and nighttime traffic sequences.

• Signs are detected based on their surface reflection properties so significant differences in colour, shape and levels of occlusion can be handled

• All signs detected are also positioned inside a National Grid (e.g. the Irish Grid) through the fusion of stereo and GPS measurements.

• The application is in road sign inventory and analysis. Future work will attempt to determine the reflective efficiency of the signs (i.e. the coefficient of retroreflection) and investigate the use of narrow bandpass interference filters for daytime usage.



Data Acquisition System

Data Acquisition System

• A portable and robust data acquisition system has been developed that makes photometric and geometric measurement on objects in the scene

• This consists of a pair of stereo cameras for making photometric measurements and local vehicle centred 3D reconstructions on objects in the scene

• A synchronised GPS receiver is used to determine vehicle position and orientation parameters

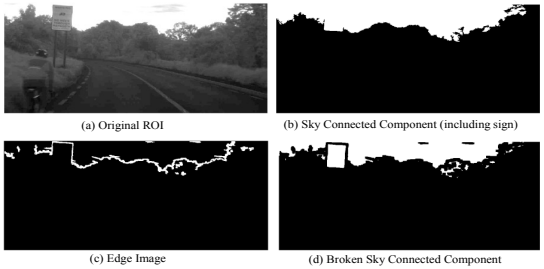
• Other surfaces in the scene do not possess this property so can be eliminated from consideration.

• Some road sign specific information is also used to reject non-road sign retroreflectors from the set of detections.

• Image analysis involved the thresholding of the cone centre image to find regions that are sufficiently bright to be retro-reflective surfaces

• Other light sources in the scene, bright or shiny surfaces and the sky area in a dusk setting are all examples of regions that may survive the thresholding process

The intensity differential for retro-reflective surfaces inside the cone of retro-reflection



(a) Original ROI (b) Sky Connected Component (including sign) (c) Edge Image (d) Broken Sky Connected Component

Breaking sky connected components with image edges to release foreground objects

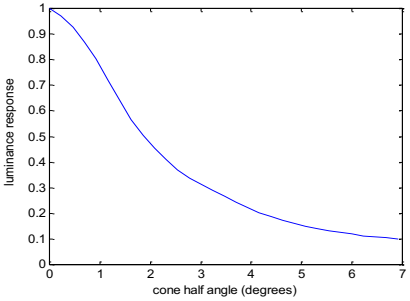
• If the sky is background to a road sign the two become merged in the same connected component so the sign cannot be analysed individually. To reduce the effect of this problem the exclusive OR of any sky connected components with an edge image is found

• Matching regions are then found in the right (cone edge) image through corss correlation. The stereo rig is fully calibrated and the images are rectified so correspondence is well constrained.

• The intesnity differential is analysed to deterimine if a retroreflective surface exists.

• The *z*-axis of the stereo coordinate system is coincident with the direction of movement of the vehicle so vehicle position and orientation actually define the translation and rotation offsets between the stereo and GPS (National grid) coordinate systems.

• Translation and rotation parameters are used in a 2D Euclidean transformation of local stereo feature coordinates to give global (National grid) feature coordinates.



Luminance levels inside the cone of retroreflection

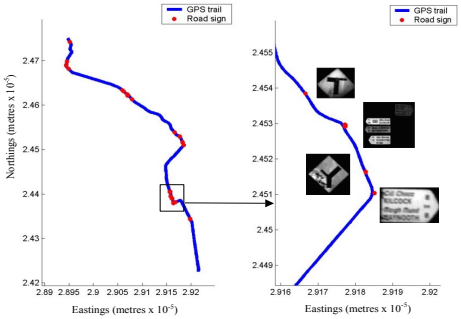
•A traffic sign detection technique has been developed that is capable of identifying retroreflectors in a single stereo pair.

• Retroreflecting road signs return a solid angle or cone of light back in the direction of the source. The luminous intensity is higher at the centre of the cone of retroreflection (CORR) than at the cone edge.

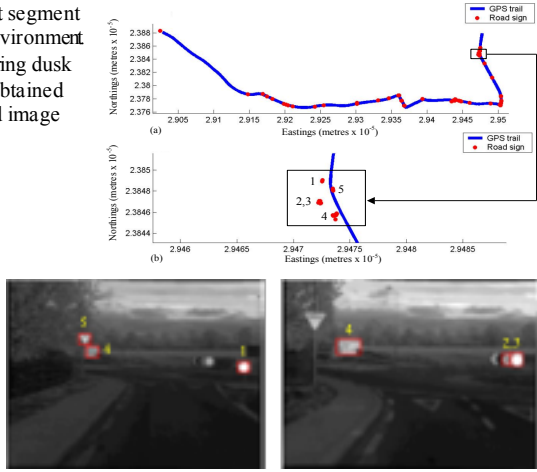
• Cameras can be placed at different locations inside the CORR to achieve contrasting luminance from retroreflective surfaces.

• One camera is placed beside an IR light source (cone centre camera) where luminance levels are relatively high and the other is placed approx. 1 metre away from the source where luminance is significantly lower.

• Results from two road segments are shown. In the first segment (below) the data was collected at nighttime in a rural environment. In the second segment (right) the data was collected during dusk hours in a more urban environment. Both results were obtained under IR illumination to increase scene illuminance and image intensities for retro-reflectors.



6 km road segment in Kildare, data acquired at night.
Detection rate: 94% of signs detected
False positive rate: 0%



5.5 km road segment in Kildare, data acquired during dusk hours.
Detection rate: 80% of signs detected
False positive rate: 17%