# What Car is That?

Peter Brook, Sam Crawley
School of Information Technology & Electrotechnology
Otago Polytechnic
Dunedin, New Zealand
peterb@tekotago.ac.nz

## ABSTRACT

The identification of an arbitrary object in a cluttered environment is a difficult problem in computer vision. Some researchers have pursued the general problem while others are looking at more constrained situations with a limited range of possibilities like face identification, handwriting and optical character recognition. There has been a lot of recent published work on automatic traffic analysis where, typically, fixed cameras are set up over a road or motorway. Roading engineers, police and local authorities have an interest in disrupted traffic flow, speeding and stolen vehicles as well as erratic driving. There are many methods to identify a car in a still or moving picture and some are mentioned in this paper. An unsolved problem remains of quickly identifying the make and model of an individual car in real time in a stream of traffic. Some vision research involving image analysis that might point the way to such identification is presented as well as a promising method of 2D analysis of car silhouettes.

## INTRODUCTION

The issues and problems of vehicle recognition are those of all forms of computer-based object recognition studied over the last few decades. Initial promising progress has given way to a complex of sub-problems and a range of heuristic methods. A human expert may be able to quote the make and model of a car given only a glimpse of it on a highway, yet the problems presented to a computer expert given the same images, are not as easily solvable. If our task is to identify each vehicle in a stream of traffic according to make and model, then we have to confront problems of tracking, occlusion, colour, shading, pose and template comparisons. While there has been much research into each of these fields in the general object identification area, there seems to be no attempt to solve the automatic recognition of vehicle by make and model in a moving stream of traffic. Some sub-problems involving the same scene have been solved. We will identify work on some of the sub-problems such as number-plate identification and class-of-vehicle discernment, as well as give an account of a plan to constrain the environment so that careful metric data can be extracted from an image, thereby leading to a look-up table of car lengths, heights and similar measurements.

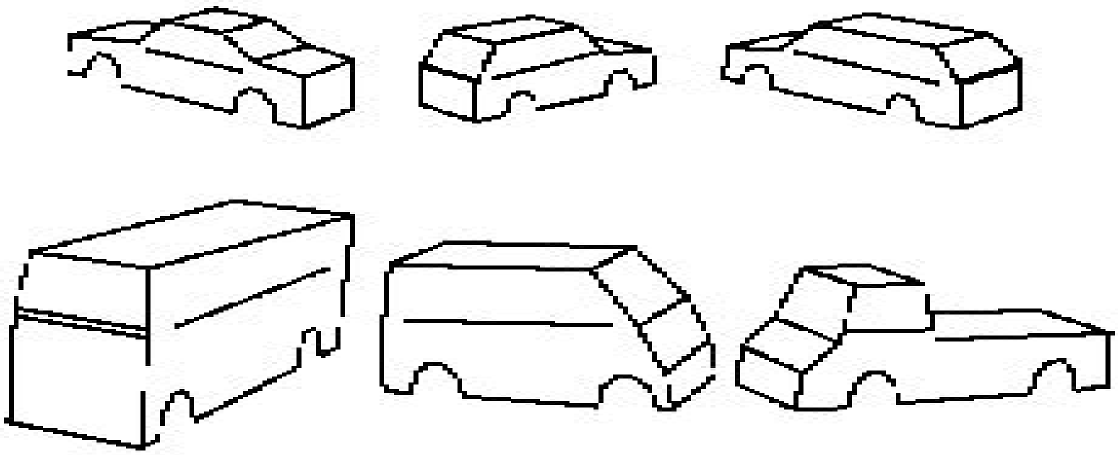

**Figure 1:**

**Ferryman's deformation of basic car shape**

One approach to solving the car identification problem is to assume that all cars are simply variations in shape and size of a generic car of known dimension. The degree to which it is elastically pulled and squashed are the very characteristics that are associated with each different car. Ferryman *et. al.* (1995) extend this notion to one of a generalised vehicle model. They report a promising method that associates a 29 parameter model with each type of car class. For example, saloon, hatchback or stationwagon. They can also report instances of trucks, vans and buses by extending their general model, which is based on a bilaterally symmetric extruded octagon plus some placement information on the bottom of the side windows and the vehicle arches.

Mark Y Chen outlined a design for a frontal recognition system that would associate an image taken of an approaching car with a stored template. The image would first be fed into a MATLAB program that would enhance and analyse the image prior to the recognition phase. Chen asserted that, "No previous work has been developed in this field of recognition" (Chen, 1999) and the authors agree, if the problem is one of distinct brand differentiation, for instance being able to conclude after being fed an image "that is a white 1996 Toyota Corolla Stationwagon". Chen also recounted difficulties with his frontal template matching method owing to a strong requirement for controlled environments and some enlargement problems.

# 1. SOME EXISTING VEHICLE RECOGNITION SYSTEMS

The Australian CSIRO's vision applications group has developed a camera and computer-based truck recognition system for motorway monitoring. Called Safe-T-Cam, it is designed to scan several lanes at once until a truck is recognised. Then a second camera takes an image of the truck's number-plate. That is decoded and sent to relevant authorities where it is automatically checked against a register of vehicles of interest. The promotional literature asserts that the system can be adapted for stolen cars, overweight vehicles, tolls and, in time, pollution exceeding instances. A series of Safe-T-Cams could track vehicles and report those who had failed to stop for mandatory rest breaks. A stated aim is for automatic in-motion weighing and a wave-through system of compliance trucks.

Another method of associating two-dimensional images with actual makes of cars is to extract information from the image that remains fairly invariant under affine transformation and then store a series of these features in a n-dimensional vector that is compared with a ground-truth set under some distance metric. The make with the closest match is declared to be the winner. The main difficulties with this method are, choice of attributes invariant under two-dimensional transformation and choice of decision procedure as to how close the match is.

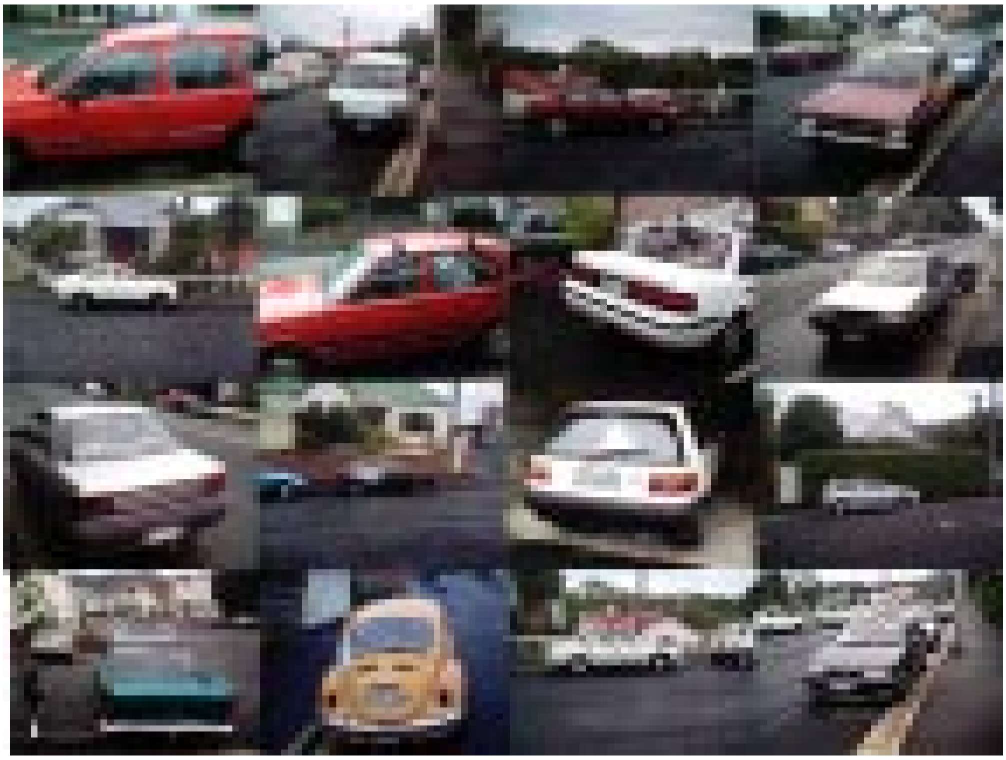

**Figure 2:**

**Randomly posed vehicles present a challenge to recognition systems**

**Figure 3:**

**The CSIRO Safe-T-Cam**

Some likely attributes involve ratios of major and minor axes of regions of interest and include aspect ratio, mean invariants with difference, compactness (perimeter$^2$/area) and mean invariants of intensity (McCane, *et al*., 1997). These unary elements can discriminate gross differences in parts of cars but also remain fairly invariant, while the camera shifts with respect to the car. Bischof and Caelli (1994) used their Conditional Rule Generation (CRG) classifier to combine the above unary transformation with binary relationships between regions to recognise small toy cars amongst other similar objects. McCane, *et al*., 1997 adapt this method to produce their "Fuzzy CRG" which appears to be a promising approach to solving the "What Car is That in a stream of traffic" problem.

## 2. LICENCE PLATE RECOGNITION

One approach to car identification that has received a lot of recent attention is number plate recognition. Given an image of a car there are systems that seek out the part of the image that is most probably the rectangle containing the licence plate. This is a usually-solvable but non-trivial problem. After the position of the plate is determined most algorithms

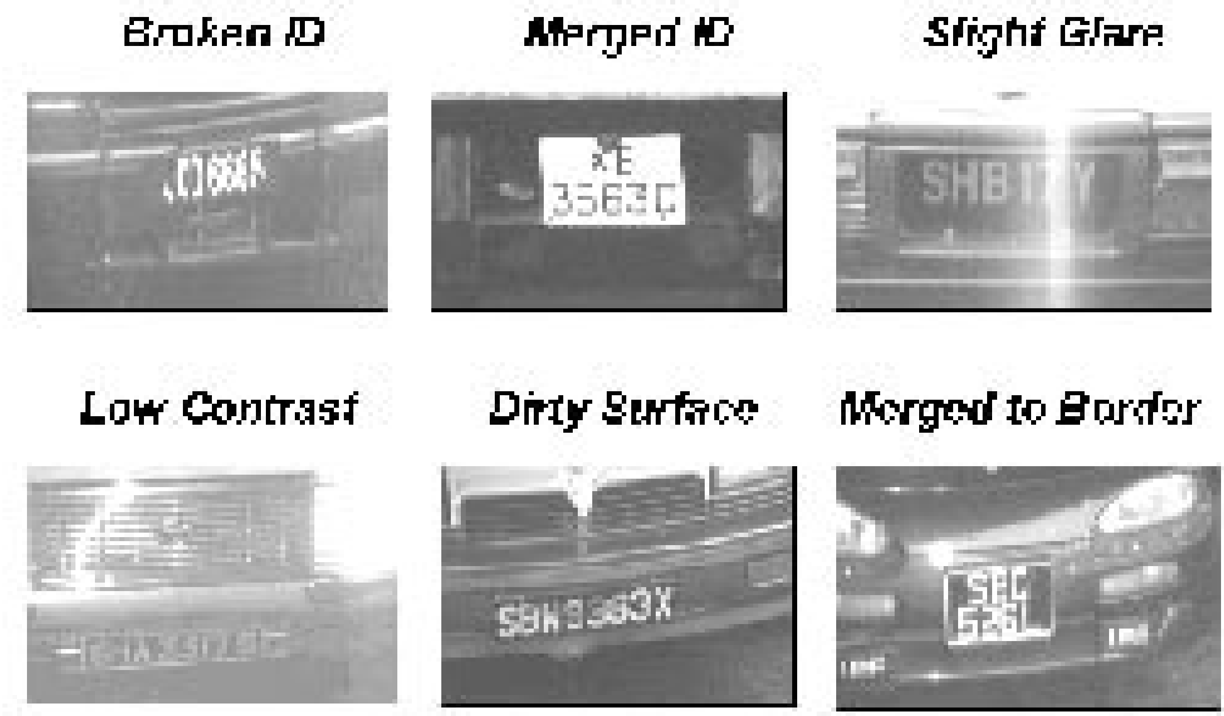


**Figure 4:**

**Some number-plate recognition challenges**

then use early OCR techniques to locate the individual characters and reject increasingly superfluous information found on contemporary plates. OCR techniques then convert the remaining images to ASCII strings that can be matched with a database of licence plates. This research area is now well into the product development area so that a local authority, police agency or parking company anywhere in the world can choose from over 30 commercial systems [http://www.ettm.com/news/lpr.html]. Most systems have to solve difficulties of number plates being badly positioned on the car as well as problems of occlusion, mud, towbars and marketing slogans.

## 3. OBTAINING EXACT DIMENSIONS

One line of attack for object identification is to examine the characteristics of the occluding silhouette, (Gdalyahu and Neinshall, 1999).

A promising related methodology for car identification trialed by the authors involves near direct measurements of cars from silhoutte images. The problem of identifying makes and models of cars in a steam of traffic flowing towards the camera on a highway has been reduced to a sub-problem of identifying individual cars going past a camera at a fixed distance and known pose. This is achieved by the use of a fixed camera which is triggered by a car going onto an on-ramp or similar against a clear background, such that a profile image is obtained at the same position every time a car goes over a triggering mechanism. Car measurements can then be read off automatically from the image by using trigonometry ratios. Out of all the measurements that are possible, we are currently exploring the use of four dimensions that we believe would characterise most cars. They are maximum height, maximum length, and the two heights of the profile above the centre of the wheel rims. Initial results indicate that if we can obtain close measurements, then the make and model of the car can be identified fairly readily. We have yet to exhaustively test this method and will report our results in a subsequent paper.


## REFERENCES

**Bischof, W. and Caelli, T., (May 1994),** "Learning structural descriptions : A new technique for conditional clustering and rule generation", Pattern Recognition, , pp 689-697.

**Chen, M.Y.,** University of Queensland, Department of Science and Electrical Engineering, http://www.cltr.ug.oz.au/-s341270/thesis page 1, date accessed Feb 2001.

**Ferryman, J.M., Worrall, A.D., Sullivan, G.D. and Backer K.D., (September 1995)** A gener deformable model for vehicle recognition. In BMVC, volume 1, pages 127-13, Birmingham.

**Gdalyahu, Y and Neinshall, D, (December 1999)**. Flexible Syntactic Matching of Curves and its Application to Automatic Hierarchical Classification of Silhouettes; IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 21, No. 12, , pg 1312.

**Galvan, B., McCane, Brendan and Novins, Kevin, (June 1999).** Virtual Snakes for Occlusion Analysis. . IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Fort Collins, Colorado.

**McCane, B; Caelli, T; de Vel, O.(1997)** "Learning to Recognize 3D Objects Using Sparse Depth and Intensity Information". International Journal of Pattern Recognition and Artificial Intelligence. Vol. II No. 6 909-931.

**McCane, B; Caelli, T; de Vel, O. (1997),** "Learning to Recognize 3D Objects Using Sparse Depth and Intensity Information". International Journal of Pattern Recognition and Artificial Intelligence. Vol. II No. 6 909-931.