University Defence Research Collaboration in Signal Processing

LSSC Consortium White Paper

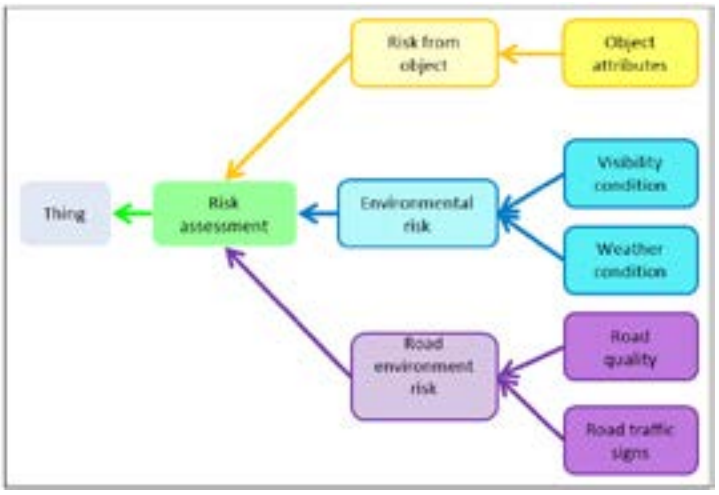
Ontology-based Framework for Video-Based Risk Assessment in Road Scenes

Introduction

In recent years, there has been considerable interest in developing unmanned autonomous vehicles. The applications of the technology enabling such autonomous systems lie in areas as diverse as defence, automotive and entertainment industries and would have wide social implications in improving the quality of human life and health.

Recent advances in autonomous vehicles technologies have resulted in intelligent automobiles which sense the environment using a variety of sensors, such as GPS, radars and cameras. By processing the information acquired by these sensors, they are capable of determining the travel route and identifying important scene objects, such as traffic signs and obstacles. An important challenge in the design of autonomous vehicles is to make them situationally aware, that is, being able to comprehend the meaning of the detected entities in the environment, and the projection of their status in the near future.

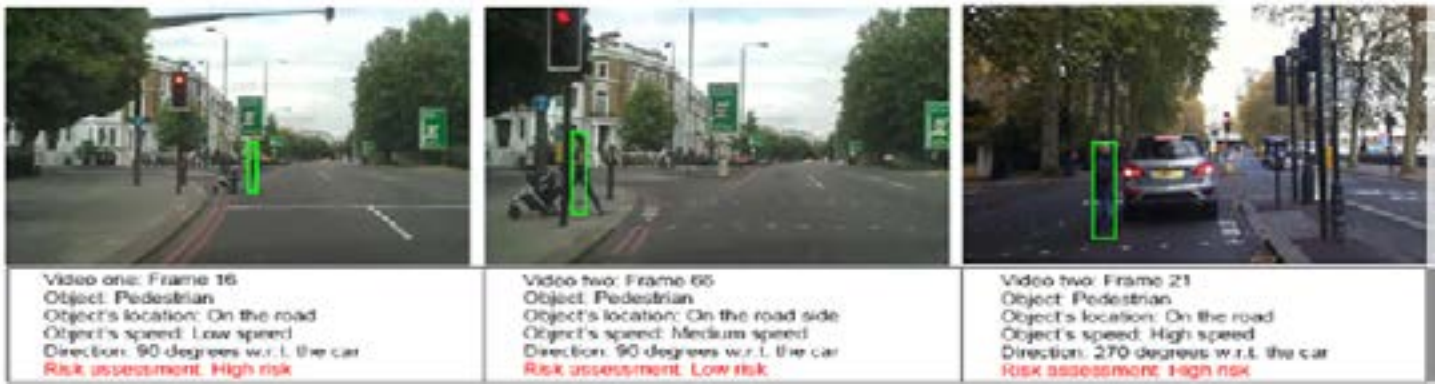
At Cardiff University, a framework was developed for assessing the potential degree of risk in a road scene for a vehicle's driver [1] i.e. the likelihood of the vehicle's collision with various obstacles such as incoming traffic and pedestrians. The framework was built around an ontology, which is a formal, hierarchical definition of the types, properties, and relationships of the entities that exist in a particular domain. Here, this domain is the road scene. The proposed framework takes into account sensor input concerning the environment entities and enables reasoning, i.e. risk assessment, by utilising the relationships and the interactions of these entities, as modelled by the ontology. Only data from a monocular video camera, capturing footage from the driver's perspective is used as input, in an efficient, cost-effective approach.



Method

The novelty of the framework stems from its ability to interpret unpredictable road traffic, as it does not assume that the road users always obey the traffic rules. Assessing the degree of risk in a road scene is more challenging when considering the more general problem of interpreting the unconstrained behaviour of entities in the scene. The proposed ontology is designed to cater for risk related to several factors, such as risk from objects (vehicles, pedestrians, cyclists etc.), environmental risk (weather and visibility condition) and road environmental risk (road quality, road traffic signs and road types).

The future work will expand the assessment of the framework to other factors contributing to risk in road scenes, such as road type, environmental conditions and incoming traffic. Furthermore, the framework will be applied to different scenarios (e.g. automatic aircraft taxiing).



Currently, the evaluation of the proposed ontology tool is focused on risk generated by pedestrian movement; evaluation of the complete ontology will be carried out in future work. The reasoning facility of the ontology tool is applied to real-life road scenes captured in monocular video. In each frame, three attributes are estimated for each pedestrian: speed, location and direction. The pedestrians are detected with the Viola-Jones detector and other important scene objects are identified (e.g. road, pavement etc.) using a novel evolving video segmentation algorithm also developed at Cardiff [2]. Once the pedestrians are detected, their location in the scene, speed and direction are estimated. These measurements are fed to the ontology tool which assesses the situation in the scene. The experimental results indicate that the proposed framework is capable of assessing risk resulting from pedestrian behaviour in a variety of road scenes with high accuracy.

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References:

[1] M.A. Mohammad, I. Kaloskampis, Y. Hicks and R. Setchi, “Ontology-based Framework for Risk Assessment in Road Scenes Using Videos”, Procedia Computer Science, vol. 60, pp. 1532-1541, Aug 2015.

[2] I. Kaloskampis and Y.A. Hicks, “Estimating adaptive coefficients of evolving GMMs for online video segmentation,” in 6th International Symposium on Communications, Control and Signal Processing (ISCCSP), pp.513-516, May 2014.