A General Dynamic Vision Architecture for UGV and UAV

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Abstract. The expectation-based 4D approach to dynamic machine vision exploiting integral spatio-temporal models of objects in the real world is discussed in the application domains of unmanned ground and air vehicles. The method has demonstrated superior performance over the last half decade in autonomous road vehicle guidance with three different vans and busses, with an AGV on the factory floor and with completely autonomous relative state estimation for a twin turboprop aircraft in the landing approach to a runway without any external support; in all application areas only a small set of conventional microcomputers was sufficient for realizing the system. This shows the computational efficiency of the method combining both conventional engineering type algorithms and artificial intelligence components in a well balanced way.

The modularity of the approach is demonstrated in a simulation set-up serving both the ground- and the air vehicle applications. Experimental results in both areas are discussed.

Key words: Machine vision, vision architecture, vehicle guidance, state estimation, modeling

1. Introduction

The problem of cognition has long bothered humans with respect to the dualistic aspects of the 'real' external and the 'mentally imagined' internal world. For many centuries, philosophers had tried to adjust the mental interpretation to the 'true' external world. It was I. Kant who, about two centuries ago after all the frustrating efforts over millennia, inverted the problem and herewith laid the foundation for a consistent scientific interpretation model. He recognized that reasoning has to start with the mind of an individual, embodied in a biological system having sensory contact to the real world outside. So, his main task was to clarify, what types of statements about the world could be made on safe ground. His main works 'Critiques of . . .' are dedicated to this problem.

He asked, what do we carry into the world with our sensing and analysis system, independent of objects and subjects which we observe? The conclusion was that 3D space and time are fundamental ('a priori') properties of our cognition system: they are not attributes of objects.

In evolution-oriented modern terms we would say that successful survival of our species is a solid foundation for the assumption that our sensing system is reasonably well adapted to the real world and that, therefore, we are justified to rely on the sensory signals from the outside world, in general. It is well known, however, that there are some flaws and that one has to be very critical with respect to the internal interpretations which have evolved over time from this. The multitude of cultural forms to be observed and the resulting different interpretation schemes for the same events (perceived signals) give an indication of the mental variety developed.

The idealist philosophers after Kant even turned the world upside down with their interpretation that the outside world is created by the mind. In this mental environment, it was A. Schopenhauer about 175 years ago who 'wanted to put the world back to its feet again' and who clearly stated the misinterpretations since Kant.