Computational Understanding of Multiple Images

Project Summary: Reactive LTR Project 21914–CUMULI

Objectives

Automated 3D measurement and model building are key technologies for precision engineering. Digital photogrammetry — 3D measurement from sequences of digital 'photographs' — has many advantages over competing technologies: it is non-invasive, fast, and allows very large working volumes, the equipment is inexpensive, robust, portable and easy to use, and there is a strong potential for full automation. European companies — including the two industrial partners of CUMULI — are world leaders in this rapidly evolving field. However, strategic research is needed to further enhance the automation and flexibility of their products. Key areas include: (*i*) More complex scene primitives (lines, circles, facets…) — current systems measure only isolated points. (*ii*) Robust extraction and tracking of primitives through multiple images. (*iii*) Ability to incorporate and reason with known geometric constraints: *matching constraints* between structure in several images; *camera calibration* (when available); and *known 3D structure* (coplanarity, known angles or distances…). (*iv*) Improved statistical modelling and computational schemes.

There has recently been an intense and very fruitful wave of research on these and related aspects of multi-image perception, lead by the European computer vision community. The academic partners of CUMULI were actively involved in the ESPRIT projects BRA VIVA and REALISE, which lead to a significant improvement in our understanding of the geometry and invariants of multiple views, and techniques for reasoning with them. CUMULI aims to capitalize on this basic research, refining and extending existing results on multi-image geometry and reasoning, and converting them to valuable industrial know-how.

Approach

1) Extend and refine current results on multiple image geometry and non-point-like primitives.
2) Derive an image-based measurement framework incorporating geometric knowledge in a symbolic form.
3) Develop efficient, robust and accurate computational schemes based on this.
4) Build advanced prototypes of three systems for 3D measurement and modelling from image data.

The academic partners will concentrate mainly on (1)–(3), the industrial partners on (4), but all partners will participate in a strong effort to develop and transfer applicable technology.

Impact

The project will significantly improve our ability to measure complex objects and scenes (non-point primitives, prior geometric constraints) precisely and automatically from images. This will increase the reliability and throughput of current vision-based production-line quality control systems, and allow new applications in flexible engineering.

Exploitation

New Products: During the project, the techniques developed will be incorporated into working prototypes and validated under industrial conditions. From there, they will feed directly into the industrial partners' product lines.
Public Awareness: The results will be publicized through the usual academic and commercial channels, at major trade fairs (*e.g.* CeBIT), and on the Internet (http://www.inrialpes.fr/CUMULI). We are also investigating the possibility of highly focused national-level industry workshops on CUMULI-related topics, as we feel that these are the best means of informing potential users of the new technology and getting feedback on their real needs.

Partners

- INRIA Grenoble (R. Mohr) and Sophia-Antipolis (O. Faugeras). French national I.T. research institute.
- Dept. of Mathematics, Lund University of Technology (G. Sparr). Specialists in multi-image geometry.
- FRAUNHOFER-IGD: German applied research institute, leader in 3D modelling and V.R. applications.
- IMETRIC: Swiss SME, specialists in precise 3D measurement from images.
- INNOVATIV VISION: Swedish SME, leaders in automated motion measurement from image sequences.