UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Computer and Robot Vision (blended)

2122-2-F1801Q149

Aims

The objective of the course is to give both theoretical foundations and practical abilities about the processing of data generated by cameras and range sensors, in order to understand the observed scene; in particular its geometry.

Contents

The course presents an introduction to machine perception topics, in particular to the perception of the geometry of the observed scene, both with computer vision and mobile robotics techniques.

Detailed program

1. Image formation
    - image formation - geometry: geometric models of projection, model-based vision (hint), the need for optics, thin lenses, blur circles and depth of view, external and intrinsic projection parameters, FOV (Field Of View), calibration of the projection parameters
    - image formation - technological issues: solid state sensors (CCD, CMOS), quantum efficiency, smearing / blooming, motion blur, vignetting, etc, 3D cameras, night visors, colour cameras (3-sensors, Bayer pattern, stacked sensors)
2. Stereoscopy
    - terminology, pixel-level and feature-based approaches
    - example of pixel level stereo-matching algorithm: correlation-based stereo-matching, and usage of multi-resolution
    - feature-based stereo-matching algorithms, hints about feature detection and description
    - epipolar geometry
3. Analysis of image sequences
    - the different problems, according to the scene and the observer motion

    - image and scene motion field
    - brightness constancy equation and the aperture problem
    - differential methods and estimation of the optical flow with an LSE approach
    - feature-based approaches
    - data association and missing information problems: effects of outliers, breakdown level, Least Median of Squares, RANSAC

4. Bayesian filtering
    - dynamical systems and Bayesian filtering
    - Kalman filter, extended Kalman filter, and usage of mixtures of gaussians
    - unscented Kalman Filter
    - non-parametric filters: hints on histogram filter, particle filter

5. Perception for mobile autonomous robotics
    - Review of kinematics of different mobile bases, Velocity Motion Model and Odometry Motion Model
    - short review of sensors for range sensing and measurement model of laser scanners
    - localization problem, EFK-based and PF-based approaches
    - SLAM PF-based (FASTSLAM) and EKF-based
    - Visual SLAM with inverse depth

Prerequisites

Teaching form

Teaching is expected to take place in italian. Nevertheless, classes and practicals will be given in english should one of the following conditions become true:

- at least one foreign student prefers to use english;
- students ask to have classes and practicals given in english.

The teaching activities will include:

- classes: pre-recorded classes;
- periodic interactive meetings about the topics covered via the pre-recorded classes;
- laboratory events (practicals, no programming);
- interactive meetings about laboratory programming practicals (matlab).

Textbook and teaching resource

- Textbooks
    - A. Fusiello, "Visione Computazionale: tecniche di ricostruzione tridimensionale", Franco Angeli, 2013
    - E. Trucco, A. Verri, "Introductory techniques for 3D Computer Vision", Prentice Hall, 1998
    - S. Thrun, W. Burgard, D. Fox, "Probabilistic Robotics", Mit press, 2005
- Other learning material
    - Short videos (audio and tablet screen used as blackboard, taken from the videos of classes from previous years) for each subtopic
    - Extra material, available on the elearning platform

Semester

First semester

Assessment method

Written verifications about the theoretical parts (image formation, stereoscopy, analysis of sequence, perception for mobile robotics) plus evaluation of matlab programs developed during the practicals (Bayesian filtering). The optional development of small applications under the guidance of the teaching assistant, results into an additive bonus on the final mark.

Office hours

Send email to arrange an appointment