Evaluation of Recent Approaches to Visual Odometry from RGB-D Images

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Abstract. Estimation of camera motion from RGB-D images has been an active research topic in recent years. Several RGB-D visual odometry systems were reported in literature and released under open-source licenses. The objective of this contribution is to evaluate the recently published approaches to motion estimation. A publicly available dataset of RGB-D sequences with precise ground truth data is applied and results are compared and discussed. Experiments on a mobile robot used in the RoboCup@Work league are discussed as well. The system showing the best performance is capable of estimating the motion with drift as small as 1 cm/s under special conditions, though it has been proven to be robust against shakey motion and moderately non-static scenes.

1 Introduction

The objective of a visual odometry system is to compute a continuous camera trajectory through examination of the changes that the motion induces on the images. Research in this area has a long history in robotics [1]. Initially motivated by the NASA Mars exploration program in the 80s, over the years it has yielded systems that were applied on in- and out-door wheeled robots, cars, aerial and underwater vehicles, and even quadruped dog-like robots [2].

The wide choice of vision systems that were used to implement visual odometry includes monocular, stereo, omni-directional and multi-camera setups. Recently low-cost RGB-D cameras were introduced to the market. These visual sensors combine a conventional RGB video camera with a depth sensor, and deliver color images with pre-registered per-pixel depth information at the standard video frame rate. RGB-D cameras have relatively low power consumption and weight which made them suitable and effective sources of information about the environment (and thus the robot's motion). This motivated many researches to explore the possibility of implementing an RGB-D visual odometry system.

Over the past few years a number of such systems were reported in the literature [3,4,5,6,7]. A closely related topic: mapping with RGB-D cameras, also enjoyed considerable attention [8,9,10,11]. The latter emphasizes globally consistent alignment of all captured data, but often involves an odometry subsystem that performs preliminary local alignment. A number of distinct approaches with various benefits and deficits, constraints, and computational complexities exist.