# CPA-SLAM

# Key idea

### Tracks the motion towards a reference keyframe (frame to keyframe)

### Aligns the image with the planes in a global modle

# Advantages

### Graph constraints between keyframes without overlapping views can be established if they observe the same model plane

### An additional benefit of our method is that it provides a compact planar scene representation

# visual SLAM that exploit planes as typical features in man-made environments

#### 07-BMVC-Discovering planes and collapsing the state space in visual SLAM

##### Use planes to reduce the amount of interest points in a monocular Kalman-filter based SLAM approach

#### 08-ICPR-Visual planes based simultaneous localization and model refinement for augmented reality

##### Planes are also included in the state-space of an EKF method to monocular SLAM

##### Focusses on the incremental optimization of the planes in a global frame for augmented reality applications

#### 08-ICRA-Orthogonal wall correction for visual motion estimation

##### Orthogonality of planes in indoor environments is exploited to improve the consistency of plane models and SLAM

#### 10-BMVC-Unifying planar and point mapping in monocular slam

##### A unified parameterization for points and planes in a monocular **EKF**-SLAM system

#### 12-ACCV-Exploring high-level plane primitives for indoor 3D reconstruction with a hand-held RGB-D camera

##### Combine planes and interest points in frame-to-frame matching and bundle adjustment

##### They detect planes using a Hough-voting scheme

#### 13-ICRA-Point-plane SLAM for hand-held 3D sensors

##### Use interest points and planes for SLAM with RGB-D sensors

#### 12-ICRA-Planar surface SLAM with 3D and 2D sensors

##### Use RANSAC to find the major planes in a scene from RGB-D and 2D laser measurements

##### SLAM is performed in an EKF framework, associating plane observations with global planes in the map

#### 14-ISMAR-Dense planar SLAM

##### Integrate incremental plane mapping into point-based fusion

# Some works also have tackled the problem of including object detection into SLAM

#### 13-CVPR-SLAM++: simultaneous localisation and mapping at the level of objects

##### Detect objects from a model database and estimate their poses in individual frames

##### The poses of these objects in the global frame are then estimated through graph optimization

#### 13-CVPR-Joint detection, tracking and mapping by semantic bundle adjustment

##### Semantic bundle adjustment

##### The objects are detected and tracked, and included as 6-DoF landmarks in a bundle adjustment framework

# Preliminaries

### A image , segment into disjoint

### Denote 3D point by , its unit normal by , its 2D pixel

### Projection (3D to 2D):

### Back-projection (2D to 3D):

### Lie algebra to transformation:

### transform from frame to frame

### transforms from frame to world, the inverse is

### Transform 3D point

### Warp pixels between frames

### Hessian form , distance from to plane

### A plane observed in frame is transformed into world

# Global Plane Model

### Global plane model , each associated with a list of in keyframes

### The global plane model is augmented incrementally

### For each keyframe

##### It is segmented into regions

##### Non-plannar region

##### The th Plane region

##### Apply the agglomerative hierarchical clustering (AHC) algorithm for plane detection

14-ICRA-Fast plane extraction in organized point clouds using agglomerative hierarchical clustering

##### For each plane segment, least squares plane fitting is used

##### Correspond to global model

A correspondence is found if the angle between the plane normals is small (< 15°) and their distances to the origin are similar

warp the current plane segment into other keyframes and examine the overlaps

If fail, it is added to the global model as a new element

# Tracking

### Photometric error

### Geometric error

### Final error

### With correspondences

##### is used to enhance the robustness and can be iteratively estimated, derived from Student-t distribution

##### indicates which region belongs to,

# A Probabilistic View on Motion Estimation

### Model parameters and

### Indicator

### Observation

# EM solution

# Keyframe selection and loop closure detection

# Grpah Optimization

# Dataset

### TUM RGB-D

###### 12-IROS-A benchmark for the evaluation of rgb-d slam systems

### ICL-NUIM synthetic scenes

###### 14-ICRA-A benchmark for RGB-D visual odometry, 3D reconstruction and SLAM

### Stanford scene3D dataset

###### 13-TOG-Dense scene reconstruction with points of interest

# SLAM using planes

### CPA-SLAM

### Dense planar SLAM

###### 14-ISMAR-Dense planar SLAM

### Point-plane SLAM

###### 13-ICRA-Point-plane SLAM for hand-held 3D sensors

# State-of-the-art RGB SLAM

### DVO SLAM

###### 13-IROS-Dense visual SLAM for RGB-D cameras

### Kinitinuous with deformable mapping

###### 15-IJRR-Real-time large scale dense RGB-D SLAM with volumetric fusion

### MRSMap

###### 14-JVCI-Multi-resolution surfel maps for efficient dense 3d modeling and tracking

### RGB-D SLAM

###### 12-ICRA-An evaluation of the RGB-D SLAM system