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BLORT - THE BLOCKS WORLD ROBOTIC VISION TOOLBOX

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COGX
Cognitive Systems that Self-Understand and Self-Extend

Abstract - The vision and robotics communities have developed a large number of increasingly successful methods for tracking, recognising and on-line learning of objects, all of which have their particular strengths and weaknesses. A researcher aiming to provide a robot with the ability to handle objects will typically have to pick amongst these and engineer a system that works for her particular setting. The work presented in this paper aims to provide a toolbox to simplify this task and to allow handling of diverse scenarios, though of course we have our own particular limitations: The toolbox is aimed at robotics research and as such we have in mind objects typically of interest for robotic manipulation scenarios, e.g. mugs, boxes and packaging of various sorts. We are not aiming to cover articulated objects (such as walking humans), highly irregular objects (such as potted plants) or deformable objects (such as cables). The system does not require specialised hardware and simply uses a single camera allowing usage on about any robot. The toolbox integrates state-of-the art methods for detection and learning of novel objects, and recognition and tracking of learned models. Integration is currently done via our own modular robotics framework, but of course the libraries making up the modules can also be separately integrated into own projects.

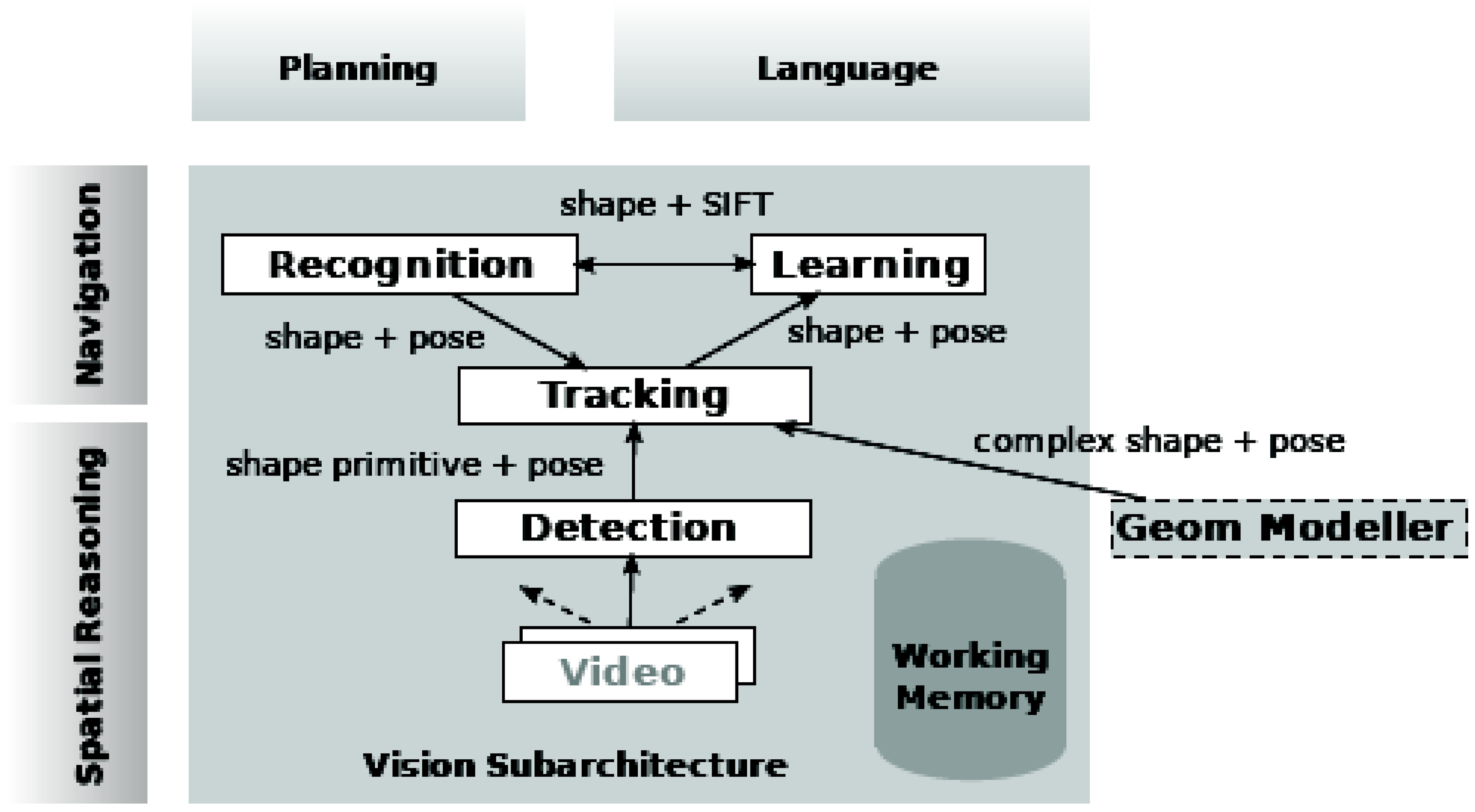


Figure 1: Vision module within the CogX project framework

Detection

- Anytimeness by incremental growing search lines: complete primitives with unbroken edges pop out first.
- Combining junctions to find closures by shortest path search.
- Perceptual grouping by using Gestalts principles.
- Evaluating 3D shape by using ground plane and symetry assumption

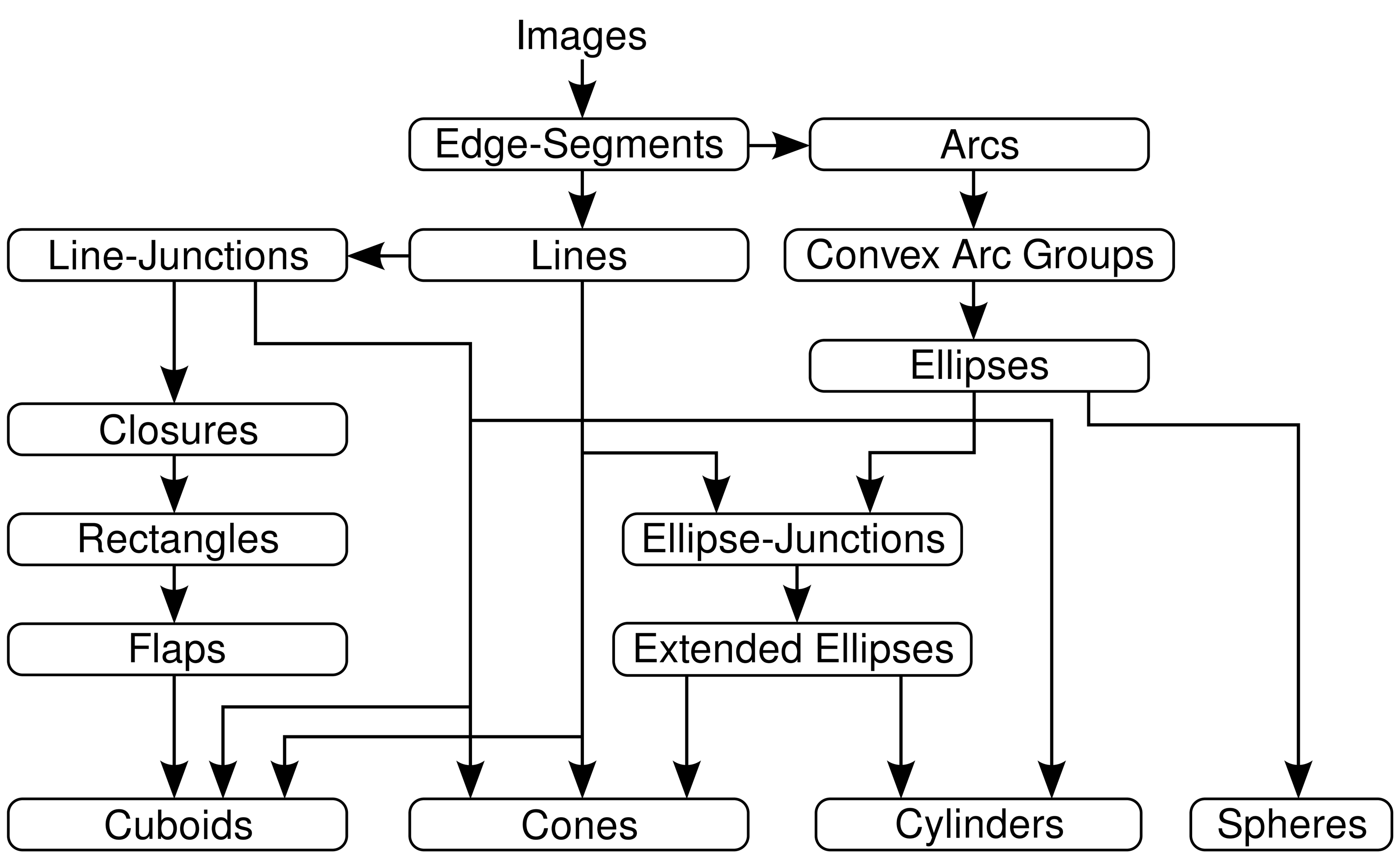


Figure 2: Perceptual grouping of basic image elements to meaningful primitives

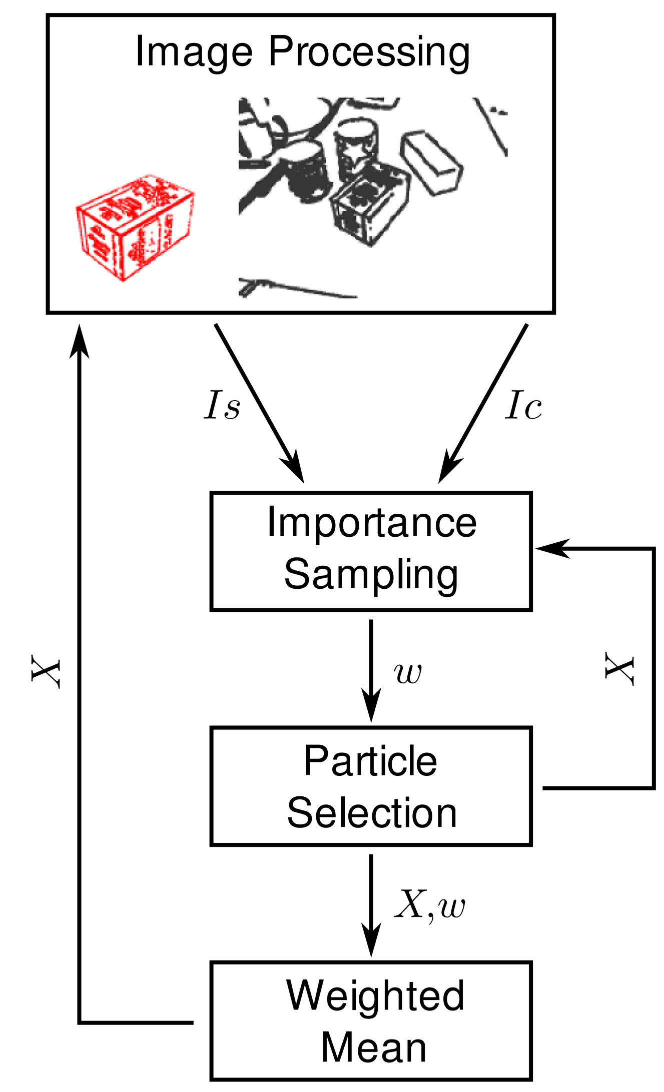
Recognition

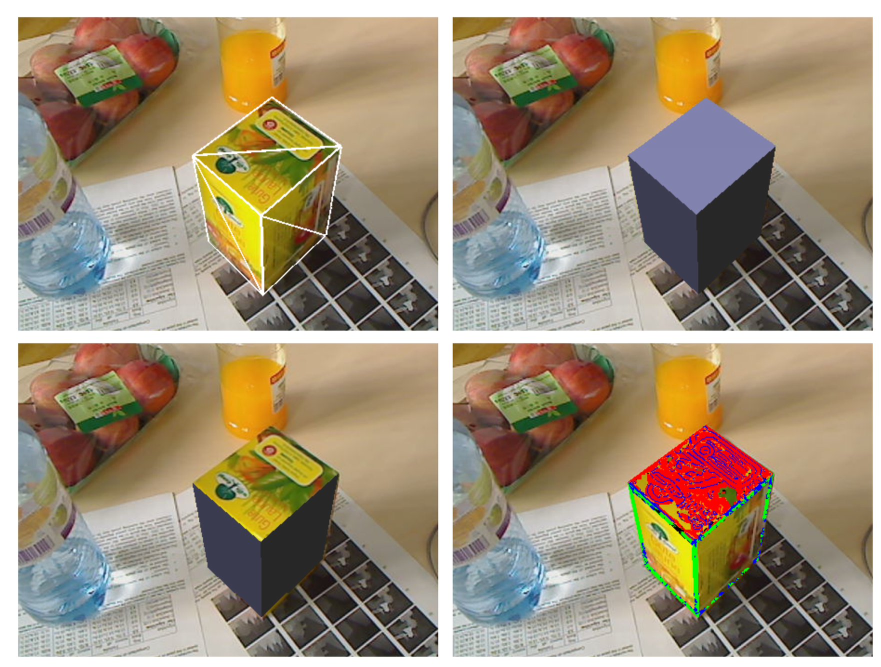
- Parallel tracking and mapping of object features.
- Learning extended SIFT including 3D position of the feature on the surface of the object.
- Reinitialisation of the tracker by recognition and pose estimation using RANSAC.

Figure 4: Recognition of SIFT and pose estimation (left) and reinitialised tracker (right)

Tracking

- Particle filtering by edge matching including texture information.
- GPU accelerated image processing and match evaluation.
- Full 3D pose estimation in real-time.
- Learning texture for robust and accurate tracking.





$$c_k^i = \frac{1}{2}\left(\frac{m^i}{n^i} + \frac{m^i}{n_{max}}\right)$$

$$w_k^i = (c_k^i)^p$$

Figure 3: Iterative particle filtering (left), learning texture and use it for tracking (top-right), particle- confidence and weight evaluation (bottom-right)

Future Work

- Removing ground plane assumption for creating 3D models by employing line-based stereo.
- Improving RANSAC pose estimation by discarding SIFTs with a surface normal pointing away from the camera.
- Including a software component for texture based reconstruction of the objects surface.
- Detailed evaluation of model and tracking accuracy.

References & Sources

[1] Mörwald T., Prankl J., Richtsfeld A., Zillich M. and Vincze M., "BLORT - The Blocks World Robotic Vision Toolbox", Best Practice in 3D Perception and Modeling for Mobile Manipulation, ICRA workshop, Anchorage, 2010
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