Mathematical Subjects & Applications in Computer Vision

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Subject : Linear Algebra

#	Key Concepts	Application in Computer Vision
1	Matrices	Image representation, color channels, basic image ops
2	Vectors & Vector Spaces	Feature vectors, embeddings, flattening images for models
3	Eigen values &Eigenvectors	PCA for dimensionality reduction, face recognition (Eigen values)
4	Singular Value Decomposition (SVD)	Low-rank approximations, image compression, denoising
5	Linear Transformations	Geometric transformations: scaling, rotation, shearing
6	Dot Product &Projections	Similarity measures, projection of features, orthogonal projections

Subject : Probability &Statistics

#	Key Concepts	Application in Computer Vision
1	Probability Distributions	Modeling pixel noise, priors in Bayesian CV
2	Bayes'Theorem	Probabilistic classification, object detection posteriors
3	Hypothesis Testing	Evaluating algorithm performance, significance testing
4	Estimation (MLE, MAP)	Parameter estimation for models, noise modeling
5	Random Variables &Expectation	Modeling stochastic processes in tracking
6	Statistical Measures	Covariance descriptors

Subject : Geometry

#	Key Concepts	Application in Computer Vision
1	Euclidean Geometry	Object shapes, distances, pose estimation
2	Projective Geometry	Camera models, homographies, 2D-3D projection
3	Transformations (Affine, Rigid)	Image alignment, stitching, registration
4	Geometric Primitives (lines, planes)	Edge detection, plane fitting in 3D scans
5	Camera Calibration	Intrinsic/extrinsic parameter estimation
6	Conic Sections & Epipolar Geometry	Stereo vision, fundamental/essential matrices

Subject : Optimization Techniques

#	Key Concepts	Application in Computer Vision
1	Gradient Descent &Variants	Training neural networks, energy minimization
2	Convex Optimization	SVMs, convex relaxations for segmentation
3	Lagrange Multipliers	Constrained optimization in pose/parameter estimation
4	Stochastic Optimization	Mini-batch training, SGD for large datasets
5	Second-order Methods (Newton)	Faster convergence for some vision models
6	Regularization Techniques	Preventing over fitting in models, sparsity constraints

Subject : Calculus

#	Key Concepts	Application in Computer Vision
1	Derivatives &Gradients	Back propagation in neural networks, edge detection
2	Partial Derivatives	Multi-variable loss optimization, filter responses
3	Integrals	Area under curve metrics, smoothing via convolution
4	Chain Rule	Gradient flow through layers for deep learning
5	Taylor Series &Approximations	Local linearization for optimization, camera models
6	Differential Equations	Modeling motion, optical flow formulations

Subject : Discrete Mathematics

#	Key Concepts	Application in Computer Vision
1	Graph Theory	Image segmentation, scene graphs, connectivity analysis
2	Combinatorics	Feature selection, counting-based descriptors
3	Logic & Boolean Algebra	Rule-based systems, shape logic, decision rules
4	Discrete Probability	Random sampling, RANSAC algorithm
5	Sets &Relations	Region labeling, set-based morphological ops
6	Finite State Machines	Tracking states, simple sequential models

Subject : Signal Processing

#	Key Concepts	Application in Computer Vision
1	Fourier Transform	Frequency analysis, texture analysis, filtering
2	Convolution &Correlation	Image filtering, template matching, CNN core ops
3	Sampling &Aliasing	Image sampling, anti-aliasing strategies
4	Filters	Noise removal, edge detection
5	Wavelets	Multi-resolution analysis, compression, denoising
6	Time-Frequency Representations	Video signal analysis, motion detection