Use Case: data-driven camera calibration for light field camera systems

Author: Youssef Daoudi El Boukhrissi (4277022)

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Use Case: Cross-Shaped Camera Array [Center + North/East/South/West]

Phase 1 — Initial Lab Calibration (once)

- Per-camera intrinsics with checkerboard across diverse poses and distances.
- Pairwise extrinsics for overlapping pairs (Center↔N/E/S/W, optionally neighbour↔neighbour).
- Global refinement over all cameras and points to remove pairwise inconsistencies.
- Store a baseline (the "good" state) for later comparison.

Phase 2 - In-Field Self-Check (periodic or event-based)

- **Triggers:** fixed interval (e.g., hourly), temperature jumps, restart, or detected shock.
- **Short capture window:** record a brief sequence during normal operation.
- **Health metrics:**
  - Reprojection error (windowed): median over the latest frames per camera/pair.
  - Parameter estimation error: deviation of current parameter estimates from the baseline/reference calibration (or *ground truth* if independently measured).
  - Parameter *drift*[1]
- **Decision:** If the combined health score (0 - 100) drops below a threshold over multiple windows, request online recalibration.

Phase 3 — Target-Free Online Recalibration

- **Trigger:** Start only when the health score has stayed below a threshold across multiple windows. When the health score stays ≤ 70 across ≥ 3 consecutive windows (e.g., 20s each).
- **Short data window:** Use a brief, recent multi-camera sequence from normal operation (no targets).
- **What to update:** Only adjust drift-sensitive internal parameters (principal point; small low-order distortion if needed). Keep the rig geometry fixed (no baseline changes).
- **Method (multi-camera BA):** Run bundle adjustment on the latest frames so that corresponding scene points align consistently in all views (i.e., lower reprojection error). No checkerboard required.
- **Commit rule:** Apply the update only if health metrics clearly improve; otherwise defer and retry later.

[1]By "drift"we mean Small, gradual changes caused by temperature, vibration, or focus shifts—can misalign the array. Even tiny misalignments degrade depth accuracy, cause stitching artifacts, and reduce overall 3D consistency.

Extras (optional but recommended)

- **Rollback & versioning:** keep the last known-good calibration and auto-rollback if a new update worsens the health metrics.