Camera Calibration Requirements

Camera calibration is the process of changing the parameters of the camera such that it can capture objects and their properties well. For AI/ML tasks, it ensures that the data is accurate and reliable. Proper calibration is critical for correct measurement, correct perspective, and reducing detection errors caused by lens distortion or misalignment.

The common goals of camera calibration include ensuring that the captured spatial dimensions reflect the real world, ensuring that the camera indeed covers the intended field f viw, removing inconsistencies caused by misalignment, and ultimately increasing the AI detection/recognition accuracy

Calibration of the camera involves the following requirements:

1. Intrinsic parameters

These are the parameters that describe the internal characteristics of the camera that affect how the camera projects 3D object into 2D plane. These parameters include the focal length, which determines the scale of the captured image along the X and Y axes, and the principal point, which specifies the optical center of the sensor. Some other intrinsic parameters are skew coefficients and distortion coefficients . Proper recognition and tuning of these parameters is crucial to defining the results of the camera calibration

2. Extrinsic parameters

These are the parameters external to the camera but still related to it. They define the camera's position and orientation in relation to the environment it monitors. These consist of a rotation matrix that holds the roll, pan, and tilt of the camera in three-dimensional space, and also of a translation vector that specifies its displacement from a reference point in consideration. These parameters are essential for capturing the parameters of real world such that the system can localize objects appropriately, estimate distances, and interpret behavior where needed. Good calibration of extrinsic parameters can ensure confidence that AI models can keep track of required objects without encountering spatial conflicts.

3. Mounting and placement

The physical location of a camera, specifically, mounting height, tilt, pan, and roll angles, is directly related to the quantity, quality and usefulness of data acquired. Mounting height decides vertical point of view and area of coverage, and tilt angle determines the field of view direction. Roll angle, rotation about the camera's viewing axis, decides the level of distortion obtained in the footage. The correct position of the camera ensures full coverage of priority zones, reduces blind spots, and avoids overlap between the areas of coverage. Careful considerations should be made while placing the camera in the required zones so as to achieve maximum accuracy with consistent coverage

On top of these, techniques like the Checkerboard method, Structured light/dot patterns, Automatic feature detection, etc., can be used to further improve the results obtained from camera calibration.