**IMUs Global Calibration Method**

**Method Description:**

We will use two cameras to calibrate all IMUs mounted on human’s legs. The calibration result contains the offset including translation and orientation of each IMU in the associated cameras’ coordinate.

**Method Details:**

For each IMU, we define several variables to describe its calibration and motion:

* The ith IMU’s initial offset (when powered up) relative to the camera’s coordinate: (unknown)
* The ith IMU’s motion including translation and orientation in its local coordinate (origin defined when the IMU powered up) at time :

For the camera system, we define the projection matrices for each camera and the extrinsic parameters of the second camera relative to the first camera:

* The projection matrix of camera 1 and 2: (need calibration)
* The transformation from camera 1’s coordinate to camera 2’s coordinate: (need calibration)

The calibration method requires good time synchronization among cameras and IMUs.

At time , we use two cameras to capture the visible IMUs mounted on human’s legs. Then we can manually extract each visible IMU’s 2D position on the images of two cameras:

* The 2D position of visible IMU’s 2D position on the 1st camera’s image:
* The 2D position of visible IMU’s 2D position on the 2nd camera’s image:

For each IMU, we get a series IMU measurements and cameras measurements:

* IMU measurements:
* 1st camera measurements:
* 2nd camera measurements:

Then we can build a linear system to solve the unknown of ith IMU:

Once we get all IMUs’ offsets , we can visualize them in a coordinate at time :

