

# Lidar-IMU Calibration using GTSAM

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## 1 Problem Statement

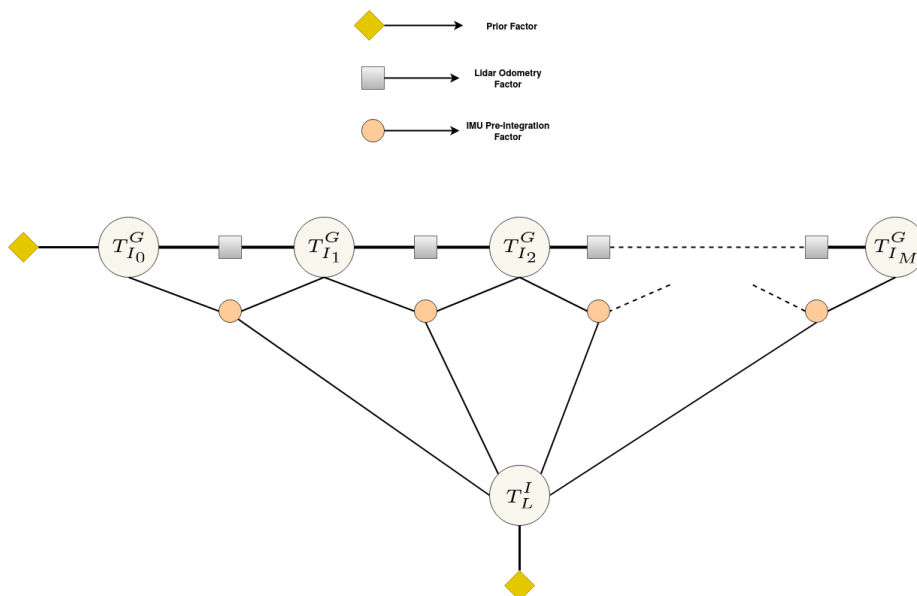


Figure 1: Factor graph of the calibration problem

I want to solve the motion based calibration problem (Figure 1) using GTSAM. In my setup I have a Lidar and an IMU. The goal is to determine the offset (extrinsic calibration) between the Lidar and IMU trajectories by solving a non linear least square problem whose one consecutive pairwise residual is:

$$T_{I_{k+1}}^I T_L^I = T_L^I T_{L_{k+1}}^L$$

$T_{I_{k+1}}^I$  is the IMU pre-integration factor (a binary factor) which depends on consecutive IMU state variables (and calculated using the IMU measurements) and  $T_{L_{k+1}}^L$  is the lidar odometry factor (a ternary factor) which depends on

consecutive IMU state variables and also on the extrinsic calibration between the two sensors (and calculated using Lidar pairwise scan matching).

Having glanced through the GTSAM documentation, I feel that the correct factor to use for the Lidar Odometry measurement is the ExpressionFactor, with:

$$z \leftarrow T_{L_{k+1}}^{L_k}$$
$$h \leftarrow (T_L^I)^{-1} (T_{I_k}^G)^{-1} (T_{I_{k+1}}^G) (T_L^I)$$

I understand that I will have to determine the Jacobians of  $h$  w.r.t state variables  $T_L^I$ ,  $T_{I_k}^G$  and  $T_{I_{k+1}}^G$ . I will be glad if anyone can let me know if this is the correct way to go about it?