**4.2.4 Odometry**

Odometry estimation is a vital step since it is not possible to robot to autonomously move, navigate and plan without the information of its position and orientation with respect to the environment. The basic odometry calculation is made using the left and right wheel velocities obtained from the motor encoders. However, this calculation alone might give inexact or wrong odometry information due to errors in the calculation of velocity or slippage of the robot wheels.

To get better and more reliable odometry information, the present-day robotics systems use IMU data or vision along with the encoders. The process called *data fusion* is applied in these cases to integrate various data. There are various advanced methods for multi-sensor data fusion which are beyond the scope of this project. However, there is a ROS package that provides data fusion for IMU and encoder data to estimate the pose of a robot using Extended Kalman Filter (EKF) named *robot pose ekf*  ~\cite{robotPoseEkf}.

Extended Kalman Filter in this case estimates an optimal value for odometry from the data of IMU and encoder and with a covariance matrix that tells how much accurate the data are. Using robot pose ekf package, the fused odometry information can be obtained. The necessary launch file is created so the nodes that publish IMU data and encoder values are started and the fused odometry information is published on a topic. The node graph can be seen in Figure ~\ref{img:ekf-graph}.

**4.2.5 Map**

It is desired to build maps using collected data from the indoor environment. ROS can record and replay messages with makes it suitable for data collection. Since the odometry of ITU-AGVs can be estimated, sensors are installed, working and ready to publish data on ROS environment it is now possible to collect the necessary data while moving the ITU-AGVs to the desired areas.

A launch file for activating the nodes for IMU and encoder reading, odometry calculations and laser reading is created.

ROS records data to *bag* files and it is very simple to record desired or all topics that are active at the time of record. In this case the laser data and fused odometry information is needed to build a map. One of the ITU-AGVs is moved using Play Station 3 joystick while the selected topics are recorded inside ITU Electric and Electronics Faculty. After the data collection is done, the recorded data is replayed and using another package called *gmapping* an offline map of Control and Automation Department corridor is built as shown in Figure ~\ref{fig:map}.