# Proposal Title

NDT Localization covariance estimation for Autoware

# Overview

This project will design, implement and evaluate a method for estimating the covariance of the localization estimate produced by the 3D NDT scan matching algorithm used by Autoware.

# Project Details:

In Autoware, the NDT algorithm estimates vehicle position within a global map by [.. detail existing algorithm …] . This algorithm has the advantages of [... detail algorithm characteristics which benefit performance …], however, it is difficult to estimate the uncertainty in the position estimate because [... theoretical or practical reasons why uncertainty cannot be estimated …] . This project uses the insight that [... idea behind the proposed solution …] and uses that fact to produce a covariance estimate for the estimated pose by [... how the idea will be implemented … ].
We will implement this algorithm in C++ and integrate it with Autoware. To evaluate the performance of the algorithm we will implement a covariance accuracy metric by comparing the produced covariance to a covariance produced by [... ground truth/offline covariance computation …]. We will evaluate this metric for simulated localization situation where we can vary the position and surrounding environment. We also plan to qualitatively evaluate the performance on the open source data set [ … reference to dataset that will be used … ]. Once implementation and evaluation we will contribute the code to the open source Autoware project.

In addition, the project proposes to experimentally evaluate the fusion of the NDT localization result with [... alternate localization algorithm …] in difficult traffic situations, to demonstrate the usefulness of the uncertainty estimation method and how it can contribute to safer, more robust Autonomous Driving.

[Supporting Images can go here]

## Expected Output:

By the end of the challenge we aim to accomplish the following:
- A modified version of the NDT Scan Matching algorithm that produces a pose estimate as well as the matching uncertainty in the form of a covariance matrix.
- Tools and scenarios to simulate and evaluate localization and uncertainty estimation performance in difficult situations
- Links to open source code repository containing the project source code as well as documentation for installation and running the code.
- Project report detailing design and implementation details, as well as explanation describing the advantages of the proposed solution in comparison with existing methods.

As extended goals we also aim to do the following:
- Integration of proposed system with Autoware software stack
- Benchmarked performance in simulated and real world data to demonstrate the method's performance in comparison to existing methods.