ABSTRACT
The project aims to provide an exciting potential to reduce the workload on the driver and automate the task of parking of long-vehicles. In the scope of this project, we designed and developed an offline mapping pipeline supported by INS/GNSS sensor [5] to create a highly accurate feature-based map. On top of that, we designed and developed a localization pipeline to localize our vehicle precisely in real time in a given map. We implemented our pipelines in Python utilizing OpenCV library where needed. We used KITTI odometry benchmarks [6] to test our system. Our test results show that the system can work up to 3.5 fps and localize the vehicle with an approximately 0.4 m RMS error in different environments.

INTRODUCTION
• U.S. Department of Transportation reveals that 94% of the road accidents are caused by the drivers [1].
• Because human drivers experience fatigue, there are strict laws enforcing truck drivers to drive for a limited amount of time in a day which makes the transportation operations inefficient and costly [2].
• Autonomous vehicles are considered as the solution, benefiting from increased safety, increased traffic flow, and reduced mobility and infrastructure cost.
• Autonomous driving is a highly attractive subject for industry and academia as well. Google, GM, Tesla, Ford, BMW and Nissan are some of the leading companies in this multi-billion dollar industry.
• There are 6 levels of autonomy established by SAE [3] ranging from fully manual to fully autonomous systems.
• Currently, autonomous vehicle industry can provide partial autonomy (Level 2 & 3) and is aiming for full autonomy (Level 4 & 5) in the foreseeable future [4].
• In our project, inline with this vision, we are aiming to design and develop vision based localization algorithms for automatic parking to be implemented on semi-trailer trucks.
• The backbone of a such autonomous system is being able to locate the vehicle accurately at all times during the process. Therefore we designed our system from scratch with the objectives:
  • Design specific camera setup for the automatic parking of semi-trailer trucks
  • Leverage the open sky operation and the existence of an accurate INS/GNSS module
  • Design and implement stereo vision based offline mapping and online localization algorithms

RESULTS & DISCUSSION
Offline Mapping

LOCATION

• In the KITTI Dataset 05, we locate our vehicle with an 0.20-meter mean error and 0.04 variance.
• We failed to keep error under 1 meter in certain situations:
  o There are other vehicles that are moving and occupying substantial portion of the image. This scenario results as an illusion of displacement even though our vehicle is not moving.
  o Certain frames does not have close objects to the camera.
• Although the system obtains inaccurate results in these situations, it successfully manages to recover its position as the localization goes on.
• There is a lack of past literature work on a complete system similar to ours which we can compare with.
• We achieved less translation RMSE compared to state-of-the-art ORB-SLAM2, although comparison is not fair since SLAM is a harder problem to solve.
• We managed to perform localization up to 3.5 fps.

CONCLUSION & FUTURE WORK
• We designed a cost-efficient camera setup for the purpose of automatic parking of semi-trailer trucks.
• We successfully mapped large datasets from urban areas.
• We obtained 0.4 m RMS translation errors during of localization of in created maps.
• Our system works in real-time with 3.5 fps where the car can travel with a speed up to 15 km/h.
• Future works of this project can be stated as:
  o Park spot detection using two monocular-wide-angle cameras are located on the sides of the truck.
  o Obstacle detection using all cameras to make the truck aware of its environment at all times.
  o Motion planning to decide necessary maneuvers to park the semi-trailer truck.
  o Performance improvements to increase localization accuracy and frame rate.

REFERENCES