# Radar-based Navigation Approaches for Off-Road Autonomous Vehicles

## Summary

*This PhD position focuses on advancing the field of autonomous off-road vehicles by addressing the challenges of precise obstacle detection using radar data. The research aims to develop cutting-edge machine vision algorithms that accurately identify obstacles under diverse weather conditions and in different environments. Additionally, the candidate will investigate methods to improve radar point cloud resolution through the use of multiple radar sensors and sensor fusion while minimizing interference. The outcome of this research will contribute to the development of more reliable and effective autonomous off-road vehicles for real-world applications.*

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| Research field: | Information and communication technology |
| Supervisors: | Prof. Dr. Eduard Petlenkov<br>Dr. Karl Janson |
| Availability: | This position is available. |
| Offered by: | School of Information Technologies<br>Department of Computer Systems |
| Application deadline: | Applications are accepted between June 01, 2023 00:00 and June 30, 2023 23:59 (Europe/Zurich) |

## Description

In recent years, there has been significant progress in the field of autonomous driving. However, the focus has primarily been on road-based vehicles, overlooking the potential of autonomous off-road vehicles. These specialized vehicles hold promise for tasks such as search and rescue, military applications, and hazardous missions where human involvement can be risky.

Traditional optical sensors like cameras and lidars are influenced by different weather conditions or obstructions such as dirt or mud. Radar sensors have emerged as indispensable tools in these situations due to their ability to penetrate adverse weather conditions and resist sensor blockage. However, utilizing radar data for precise obstacle detection presents unique challenges. Radar sensors generate sparse point clouds, requiring the development of innovative approaches to extract usable data.

This PhD position seeks to address these challenges by exploring cutting-edge methodologies for detecting obstacles through the fusion of radar data and machine vision algorithms. The PhD candidate will be researching machine vision algorithms capable of accurately identifying obstacles using limited radar data under different weather conditions and in different environments. The candidate will also investigate ways to improve radar point cloud resolution by utilizing multiple radar sensors or combining radar point clouds with data from other sensors, while minimizing negative effects, such as possibly interference.

This research will play a pivotal role in advancing the capabilities of autonomous off-road vehicles, rendering them more adept and dependable in diverse real-world scenarios.

**Responsibilities and foreseen tasks**

1. **Conducting a comprehensive literature review:** The student will review existing literature on radar-based obstacle detection, machine vision algorithms, and off-road navigation to establish a solid foundation for the research. Additionally, the student will familiarize themselves with the theoretical operation of radar sensors.
2. **Collecting and analyzing radar data:** The student will design experiments to collect real-word radar data from the real environment. This will involve finding out the best configurations for the radar sensors for autonomous off-road navigation, capturing data in different scenarios, and developing methods for preprocessing the data for subsequent analysis.
3. **Developing algorithms for radar-based obstacle detection:** The student will design and implement innovative algorithms, especially in the domain of machine vision, to process the radar data and extract meaningful information related to obstacles.

4. **Integrating radar data with other sensors**: As off-road vehicles typically have different kinds of sensors, such as cameras and lidars, the student will explore methods to combine radar data with data from other sensors to improve obstacle detection accuracy and reliability.
5. **Evaluating algorithm performance:** The student will design evaluation metrics and conduct extensive experiments to assess the performance of the developed machine vision algorithms.
6. **Collaboration and knowledge sharing:** The student will actively work together with engineers from the industry, participate in research discussions, and present scientific findings at high- level conferences and journal articles.

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