Research Field And Department	Computer Vision Systems engineering and Automation
Supervisor	Alberto Jiménez Hormeño
Title of the Work	AI Techniques for Off-Road Autonomous Navigation

Abstract:

This work focuses on Deep Learning based perception for off-road autonomous ground vehicles. The project is centered on semantic understanding of natural environments and on deriving actionable traversability estimates from multisensory data. Students will work with different sensors such cameras, LiDAR, IMU and GPS to build a pipeline that performs obstacles, terrain and vegetation segmentation, as well as map generation in real time. Emphasis is placed on good experimental practice: data collection, calibration and synchronization, reproducible training/evaluation, and concise metrics, together with robustness to noise and environmental variability. The outcome is a documented, reproducible perception stack evaluated in real-world environments, highlighting limitations, failure modes and avenues for improvement.

Main Tasks to Carry Out:

1. Literature Review on AI-based Navigation Policies: Research and analyze existing techniques for autonomous vehicle decision-making, focusing on Deep Learning applied to offroad vehicles, focusing its use on environmental interpretation. This task includes reviewing previous studies on Neural Networks and their implementation in autonomous vehicles in challenging terrains.
2. Sensor Setup and Data Preparation: This task involves configuring some sensors within a specific robot and environment. The core goal is to generate and record high-quality training datasets. This means capturing synchronized sensor data streams perfectly paired with "expert" driving commands, performed by a human operator or an automated planner.
3. Development and Implementation of Computer Vision Models: Design and train Deep Neural Networks that take the sensor data previously prepared. The main objectives are semantic segmentation, irregular terrain detection, and traversability estimation.
4. Integration of Perception Data: Evolve the model's input from raw sensor data to include processed perception data. Analyse if providing "smarter" data improves the driving decisions. Implement data fusion algorithms that provide a more accurate and complete view of the environment in real time.
5. Validation and Safety Analysis: Evaluate the trained "AI driver" in new, unseen simulation scenarios and maps. Analyze its robustness, failure cases and how its performance compares to previous works.

References/Bibliography if required

Several articles will be provided to the students before their stage.