



STUDENTS AS
CO-CREATORS

A Curriculum Design Collaboration

AI-Powered Object Detection and Obstruction Avoidance Rover

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Academic Year 2025-2026

1. Where did the inspiration to do the project come from?

The original idea for a robot car project was proposed by Muharrem as a summer project in 2025. Initially, the concept involved building a robotic rover from scratch using Raspberry Pi and robotic parts. This idea then evolved to focus more on integrating machine learning techniques rather than by building on a ready-made rover.

2. What did you set out to achieve?

Our project focused on assembling a working prototype of an AI-Powered Object Detection and Obstruction Avoidance Rover using an existing Waveshare UGV kit, integrating Raspberry Pi as the primary compute platform.

The primary objective was to create a platform that demonstrates real-time perception and avoidance behaviours, while also serving as a foundation for future research in autonomous systems. Once assembled, the rover would enable the exploration of several areas, including:

- How efficiently can a compact rover detect, classify, and react to obstacles using computer-vision-based object detection models?
- How much can supplementary sensors (ultrasonic, IMU, GPS, LIDAR) improve detection reliability and obstruction avoidance decision-making?
- What strategies allow the rover to convert perception data into safe, autonomous movement in varied outdoor environments?
- How can this prototype function as a scalable platform for ongoing and future robotics and AI development at Westminster?

While these questions outline the broader research potential, our immediate goal was the successful assembly and functional demonstration of the rover. By delivering a working and extensible prototype, the project provides a solid foundation upon which future student teams can implement more advanced perception, navigation, and autonomous decision-making capabilities.

3. Results.

During the project, we discovered that the Pi version we were using did not provide sufficient processing power to simultaneously support a high-quality live camera preview, perform real-time object detection, and transmit movement commands to the rover. As a result, the project scope was adjusted to prioritise autonomous movement and obstacle avoidance over live visualisation.

The camera was first tested independently to verify that object detection worked correctly and to allow any necessary adjustments to the code. Once satisfactory performance had been achieved, the detection system was disconnected from a preview and integrated with the rover.

Although the rover does not yet provide robust autonomous navigation, it successfully demonstrates basic obstacle avoidance behaviour in controlled environments. The implemented algorithm enables the rover to move forward continuously until an obstacle is detected. When an object enters the predefined detection region directly in front of the rover, it performs a slight

turning manoeuvre before continuing forward. This process repeats within a continuous control loop, allowing the rover to avoid multiple obstacles sequentially.

To improve navigation behaviour, the object detection region was restricted to the area immediately ahead of the rover. This prevents the rover from reacting to distant objects that do not present an immediate collision risk, reducing unnecessary turns and producing more stable movement. While the current implementation has limitations, the successful integration of computer vision with autonomous obstacle avoidance demonstrates the feasibility of the platform and provides a practical foundation for future enhancements.

4. How did students and staff work together on this project?

Communication throughout the project was coordinated using a Microsoft Teams groupchat, allowing students and staff to stay in regular contact. Initially we planned to meet weekly. However, due to assessment deadlines, internship applications, and other commitments, it was agreed that dedicating several full days to the project after the examination period would be a more effective approach.

Before the practical work began, Muharrem assembled the UGV Rover from the Waveshare kit, enabling the team to focus on software development and computer vision. At the first project meeting, Muharrem, Aleksandra, and Myroslav discussed the project objectives, reviewed what was realistically achievable, and divided responsibilities between rover control, connectivity, and computer vision development. Muharrem also provided guidance on useful resources, suggested where to begin, and helped establish the project's priorities.

Throughout the project, the students regularly updated Muharrem on their progress, creating opportunities for continuous feedback and problem-solving.

Due to the project being very hands-on, the team arranged collaborative working sessions that accommodated everyone's schedules. These sessions allowed all members to observe the rover's behaviour, discuss technical challenges, test improvements, and make decisions together. This close collaboration between students and staff reflected the principles of the Students as Co-Creators scheme by fostering a supportive, respectful, and collaborative working environment in which everyone actively contributed to the project's success.

5. What kind of impact do you anticipate that your work may have on learning and teaching going forward (specific to your course/module or in a broader context)?

The initial concept of a robot-car remains well suited to a Robotics module, while this version builds upon those foundations, incorporating computer vision elements. The project is highly scalable and can be adapted to suit different areas of study:

- Robotics: Similar to the initial idea, design and build a rover from scratch, selecting suitable components and developing a robust platform capable of operating across different terrains, together with software to control its movement.

- Machine learning: Extend the project by implementing custom object detection models, object avoidance, path planning, and integrating additional sensors such as GPS, IMU, or ultrasonic.
- Website development: Develop a web application that provides a live video stream from the rover, system monitoring, and remote control functionality, allowing users to operate the robot through a browser.

This project would make an excellent third-year undergraduate or Master's project. Perhaps the project could connect students across various courses and encourage them to work together, showcasing their strengths and learning different skills from one another. While this implementation adapted and fine-tuned existing computer vision techniques, a more advanced version could require students to collect their own datasets, train custom machine learning models, and optimise them for automatic navigation.

The concept also has many real-world applications. Similar technologies can be used in autonomous floor-cleaning robots, warehouse and delivery robots, shopping carts that follow customers, and ultimately self-driving cars.

6. Any lessons learned from working in partnership?

Working in partnership strengthened our teamwork, communication, time management, and project management skills. When half of the original team withdrew from the project and time became more limited than anticipated, we had to reassess our objectives and focus on delivering a strong, well-developed foundation rather than attempting to implement too many features at a lower standard. This experience highlighted the importance of setting realistic goals, adapting to changing circumstances, and holding ourselves accountable for both achieving our objectives and maintaining the quality of our work.

The partnership also provided valuable experience of working in a professional and collaborative environment. Unlike the part-time retail roles that many students typically undertake, this project offered insight into the way technical projects are planned, developed, and reviewed within industry. Receiving regular feedback from an academic mentor while taking ownership of the implementation helped us better understand the expectations and responsibilities of professional software development.

Each member of the team brought different skills and perspectives to the project, making collaboration particularly rewarding. By recognising and building on each person's strengths, responsibilities could be allocated effectively while still providing opportunities to learn from one another. Conducting independent research, solving practical challenges, and applying new knowledge throughout the project enabled everyone to develop both their technical expertise and their confidence in working as part of a multidisciplinary team.