

Robotics

with Dr Hao Zhang

Talking points

Knowledge

1. What are some real-world situations where teams of robots are currently being used or could be used in the future?
2. What is collective intelligence?

Comprehension

3. Why might one robot not be enough to complete complex tasks in real-world environments?
4. What does the term 'lifelong autonomy' mean, and why is it essential for robots working in unpredictable situations?

Application

5. How could a team of robots use their different abilities to respond to a natural disaster such as an earthquake?
6. How might robot teams benefit from applying teamwork strategies used by humans?

Analysis

7. What types of challenges do robot teams face in unpredictable or changing environments?
8. How are 'autonomous group introspection' and 'coopetition' similar, and how do they differ in helping robot teams function better?

Evaluation

9. How might relying on robot teams in high-stakes situations (e.g., disaster response) affect human responsibility and ethical decision-making? What might the consequences be if a robot team makes a wrong decision, and who should be held accountable?
10. If robot teams become highly autonomous and adaptable, what skills might humans need to work alongside them in the future? What new roles do you think humans might play in industries where robot teams are common?

Activity

Hao and his team are developing robot teams that can think, learn and adapt – much like human teams do. Through the Autonomous Group Introspective Learning and coopEtition (AGILE) for Cross-Capability Multi-Robot Adaptation project, they are teaching robots how to reflect on their own performance, work together and even compete in healthy ways to solve complex problems.

- Choose a real-world problem where robot teamwork would be useful (e.g., rescuing people after an earthquake, repairing a damaged space station, exploring the deep ocean, inspecting dangerous infrastructure, such as bridges and power plants, farming in hard-to-reach terrain, etc.)
- Devise a team of three different robots, each with a unique ability. For each robot, answer the following:
 - What is the robot's special ability (e.g., flying, scanning, lifting, navigating rough terrain, etc.)?
 - What is its specific role in solving the problem?
 - How will it work together with the other robots?
- Imagine your robot team is halfway through its mission when something goes wrong (e.g., one robot breaks down, the environment changes or the task becomes more difficult). Answer the following questions:
 - How will the team adapt using introspection (monitoring and adjusting their own behaviour)?
 - How might coopetition (working together while also optimising individual performance) help the team reassign tasks or solve problems more efficiently?
 - How does your team's collective intelligence help it overcome these challenges?

Reflection questions

- How did you decide what roles or abilities your robots should have?
- What was the most challenging part of designing a robot team?
- How did your robots demonstrate teamwork?
- Which human skills or behaviours do you think are hardest for robots to replicate?
- What risks or concerns could arise from relying on robot teams in critical situations?
- How might designing robot teams like this help solve real-world problems in the future?

More resources

- Explore the Human-Centered Robotics Laboratory's YouTube channel to see their robots in action: youtube.com/@human-centeredroboticslab1553
- Try out Robocode, a programming game where the aim is to develop a robot tank to battle against other tanks: robocode.sourceforge.io
- Explore the links on this list of helpful and informative resources for budding roboticists: github.com/RoseCityRobotics/robotics-resources