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(Vehicular robotics focus, new course, Undergraduate)

(Supports learning in: Simulation modeling, Programming, Systems, Networks, Data Science and HRI)

Module 1: Introduction to Robotics (UAV focus)

- Introduction to the broad domain of UAV.
- Some popular terminology, interesting facts, related concepts in Computer Science,

Module 2: Foundations of CS for UAV.

- Basics of programming (Blockly, Python, Lua).
- Data structures & algorithms essential for robotics.
- **Assignment**: Write a basic program for a robot's movement (simulation).

Module 3: UAV Hardware & Components

- Introduction to sensors (like IR, ultrasonic, cameras).
- Actuators, motors, and controllers.
- **In-Class Work**: Disassemble a basic robot kit to understand its components (MBOT or Robolink)

Module 4: Robot Kinematics & Dynamics (Both vehicular and industrial/robotic arm)

- Basics of robot kinematics (forward & inverse).
- Dynamics & control.
- **Assignment**: Using a software tool, simulate a robot arm's movement, movement of UAV, UGV

Module 5: Robot Perception

- Basics of computer vision.
- Introduction to sensors and sensor fusion.
- **Interactive Session**: Hands-on work with computer vision tools like OpenCV.

Module 6: Robot Navigation & Path Planning

- Basics of robot navigation.
- Path planning algorithms (e.g., Dijkstra, A*).
- **In-Class Work**: Program a robot to navigate a simple maze. (MBOT ground robot, Robolink Co-drone UAV)

Module 7: Machine Learning & Robotics

- Introduction to machine learning in robotics.
- Implementing basic neural networks.
- **Assignment**: Create a basic robot learning application using TensorFlow/PyTorch.

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Module 7: Human-Robot Interaction (HRI)

- Basics of HRI.
- Design considerations for effective HRI.
- Interactive Session: Interaction with robots having different HRI designs.

Module 8: Ethics in Robotics & AI

- The moral implications of robotics.
- Bias in AI & machine learning.
- Case studies on the ethical dilemmas in robotics.

Module 9: Capstone Project (Work on this module proceeds throughout the semester)

- Guidance Session: Brainstorming and project proposal.
- Implementation Phase: Building a robot/robotic application using knowledge from the course.
- Presentation: Showcase projects to peers and faculty.

Supplementary Activities:

- **Workshops**: Hands-on sessions on specific tools or techniques, using a simulation platform and learning its basic functions.
- **Group Discussions**: A discussion session to decide on a current research challenge and create a term project based on selected questions.
- **Project**: Use the simulation platform to create an implementation of a robot of choice based on concepts learned and challenges discussed.

Additional Supporting Materials:

Students will be provided with excerpts from the latest research papers on the related topic for reading and summarizing activity.

Code and tutorial resources for the choice of platform and equipment will be provided via LMS and physical copies.

Notes

1. This is a sample module-based structure for the above course. Usual graded activity will include one midterm exam and one final exam (although this may be converted into a **project + short research paper writing + 10-minute talk** after consultation with the department/ in compliance with requirements)

2. Factors such as the number of lectures and module content can be tweaked based on department and student requirements.

3. Changes in terms of hardware simulation platforms used may happen according to funding, space, availability, compliance, and regulations (in the case of **UAV/UGV**) and a short student survey that asks them to list their interests and opinions.

4. An option to switch out individual modules based on student interest and progress, or in case of limited time constraints or unforeseen scheduling issues.

5. In the last month, students (individual or group) will be asked to frame one **open-ended research challenge** question. A final report submitted by them on that topic will be reviewed and plans for further research, poster, or publication on that topic will be encouraged.