YILDIZ TECHNICAL UNIVERSITY
MECHATRONICS ENGINEERING 2024-2025 MST-BC TOPICS
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Project 1: Language-Driven Mobile Robot with Multi-Modal Interaction and Real-time Object Detection

Project Overview

This project expands upon the original by incorporating multi-modal interaction and real-time object detection. The robot will now be able to understand and respond to not only verbal commands but also gestures and visual cues. Additionally, it will be able to detect and interact with objects in its environment.

Key Components and Technologies

- **Multi-modal Interaction:** Explore incorporating other modalities like gestures or facial expressions to enhance user interaction.
- **Gesture Recognition:** Implement algorithms to recognize common gestures (e.g., pointing, waving) using cameras or depth sensors.
- **Facial Expression Analysis:** Analyze facial expressions to determine user intent or emotions.
- **Computer Vision:** Use deep learning models (e.g., YOLO, Faster R-CNN) to detect objects in real-time and to enable the robot to interact with specific objects in the environment.
- **Fusion:** Combine information from multiple modalities (language, gestures, visual cues) to improve understanding and response.
- **Decision-making:** Develop strategies to prioritize and respond to different types of input.

Project 2: Voice-Controlled Robotic Arm with Object Recognition, Human-Robot Interaction, and Multi-Modal Control

Project Overview

This enhanced project adds object recognition, human-robot interaction, and multi-modal control to the original concept. The robotic arm will now be able to identify and manipulate objects, interact with humans in a more natural way, and be controlled through a combination of voice commands, gestures, and other modalities.

Key Components and Technologies

- **Object Recognition:** Integrate object recognition capabilities to enable the robot to identify and manipulate objects in its environment.
- **Object Grasping:** Develop algorithms to determine optimal grasping points and execute precise grasps.
- **Human-Robot Interaction:** Explore ways to enhance human-robot interaction, such as providing feedback or adapting to user preferences.
- **Social Cues:** Recognize and respond to social cues, such as eye contact and body language.
- **Collaborative Tasks:** Enable the robot to work collaboratively with humans on shared tasks.
- **Multi-Modal Control:** Consider combining voice control with other modalities like gestures or button presses for more flexible control.
- **Gesture Control:** Implement gesture-based control for specific actions or tasks.
- **Button Control:** Provide physical buttons or switches for additional control options.

Project 3: Language-Guided RC Submarine with Camera

Project Overview

This project aims to develop an RC submarine that can be controlled using natural language commands and equipped with a camera for underwater exploration. The submarine should be able to understand and execute commands like "Go deeper," "Turn left," or "Take a picture."

Key Components and Technologies

- **RC Submarine:** Select a suitable RC submarine platform with necessary components like motors, propellers, and a depth sensor.
- **Camera:** Install a waterproof camera on the submarine to capture underwater images and videos.
- **Natural Language Processing:** Implement an NLP model to process natural language commands and extract relevant information.
- **Control System:** Develop a control system to translate commands into appropriate motor control signals.
- **Navigation:** Implement algorithms for navigation and obstacle avoidance in underwater environments.
- **Object Detection:** Integrate object detection algorithms to identify underwater objects and landmarks.
- **Data Analysis:** Implement data analysis tools to analyze captured images and videos for scientific or recreational purposes.

Project 4: Laser Projector that can Draw Specified Shapes and Letters (Galvanometer)

Project Overview

This project seeks to create a laser projector that can accurately draw specified shapes and letters using a galvanometer system. The projector should be able to accept input from a computer or other device and generate the desired output.

Key Components and Technologies

- **Laser:** Select a suitable laser source with appropriate power and wavelength.
- **Galvanometer:** Implement a galvanometer system to precisely control the laser's position in two dimensions.
- **Optics:** Design and assemble an optical system to focus and project the laser beam onto the desired surface.
- **Control System:** Develop a control system to generate the necessary control signals for the galvanometer based on the input data.
- **Software:** Create software to accept input (e.g., CAD drawings, text) and convert it into appropriate control signals.
- **Color Laser Projector:** Explore using multiple lasers of different colors to create colored projections.

Important Notes on Hardware Procurement!

- Students will be responsible for sourcing and acquiring the necessary hardware components for both projects. This can be done through a combination of purchasing and seeking sponsorships.
- Purchasing: Students should research and identify reliable suppliers for the required hardware. They should consider factors such as cost, quality, and availability when making purchasing decisions.
- Sponsorship: Students should actively seek sponsorship from companies, organizations, or individuals who may be interested in supporting their projects. They can approach potential sponsors with a well-crafted proposal outlining the project's goals, benefits, and the specific hardware needs.
- TUBITAK 2209A or 2209B Project Funding: Students are encouraged to apply for TUBITAK 2209B projects to secure funding for their projects. If their applications are accepted, they can utilize the allocated budget to purchase hardware or cover related expenses. Communication and coordination with Dr. Bayraktar will be essential to ensure that the budget is used effectively and in accordance with project requirements.
- Supervisor Oversight: Dr. Bayraktar will provide guidance and oversight throughout the hardware procurement process. Students should consult with Dr. Bayraktar to discuss their purchasing plans, obtain necessary approvals, and ensure that the acquired hardware aligns with the project's objectives.

Notes on Project Procedures!

- You don't have to wait for the semester to begin!
- Interested teams can reach out anytime for more information by email (eb@yildiz.edu.tr) or request a meeting to get started.
- Teams can consist of 2-4 students.
- Conduct a thorough literature review to identify existing work in the field.
- **Propose innovative ideas to make your project unique and contribute to the field's advancement.**
- **Weekly team meetings (in-person or online) are mandatory for all members.**
- A dedicated Microsoft Teams group will be created for each team. This platform allows for: File sharing, Meetings, Task management, Documentation and communication.
- Work deemed suitable will be considered for presentations at national/international conferences, submissions for utility models/patents, or publication in national/international journals.

Useful links for the projects:

- https://chatgpt.com/
- https://gemini.google.com/
- https://vlmaps.github.io/
- https://research.google/blog/visual-language-maps-for-robot-navigation/
- https://robotics-transformer2.github.io/
- https://sites.google.com/view/smart-llm/
- https://github.com/bilel-bj/ROSGPT_Vision
- https://vision-language-adr.github.io/
- https://sites.google.com/view/dragon-wayfinding/home
- https://roboflamingo.github.io/
- https://source-robotics.com/products/parol6-robotic-arm?srsltid=AfmBOooO4xy28nmxFL3YzOjtjOoOWTYTSQ87-61Pqv_UaKwUbBCj-hjm
- http://thor.angel-lm.com/
- https://arctosrobotics.com/
- https://www.niryo.com/
- https://www.bcn3d.com/bcn3d-moveo-the-future-of-learning-robotic-arm/
- https://www.instructables.com/MOTUS-Open-Source-3D-Printed-Robotic-Arm/
- https://github.com/openvla/openvla
- https://github.com/vlmaps/vlmaps
- https://github.com/robotics-survey/Awesome-Robotics-Foundation-Models
- https://github.com/vision4robotics
- https://github.com/GT-RIPL/Awesome-LLM-Robotics
- https://www.roboticsproceedings.org/rss19/p032.pdf
- https://www.cnx-software.com/2022/06/06/mecharm-pi-270-desktop-robotic-arm-raspberry-pi-4-sbc/
- http://elm-chan.org/works/vlp/report_e.html-https://optoshop.optoman.com/?gad_source=1&gclid=CjwKCAjwodC2BhAHEiwAE67hJKbcDrToeiA_U-QyRN0q4fqfr2R1uP-D4LRcdFKUNHrmCY7mhiNSPxoCqfYQAvD_BwE
- https://www.thorlabs.com/navigation.cfm?guide_id=2269
- https://www.instructables.com/HOW-TO-MAKE-ADVANCED-LASER-PROJECTOR/
- https://www.instructables.com/DIY-Submersible-ROV/
- https://utahrov.org/how-to-build-an-rov
- https://www.instructables.com/Build-Your-Own-Underwater-Robot-V2/
- https://www.instructables.com/3D-Printed-Fish-Feeder-RC-Boat-With-Controller/
- https://www.scanlab.de/en/products/galvanometer-scanners?gad_source=1&gclid=CjwKCAjwodC2BhAHEiwAE67hJF8Vs7XC3kw2Ez-1ui7epwCazbHUpWW6e-3aVUDRgVY4S5i_Rx87eRoC4t4QAvD_BwE
- https://www.youtube.com/watch?v=uzoFIEVqXRo
- https://www.sci-projects.org/blog/building-a-laser-galvo-scanner-from-sratch
- https://www.instructables.com/DIY-STEPDIR-LASER-GALVO-CONTROLLER/
- https://github.com/ThingEngineer/Laser-XY-Scanner
- https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=6057
- https://brickexperimentchannel.wordpress.com/rc-submarine-4-0-blog-post-series/