COLLEGE OF ENGINEERING
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

CPE498 Capstone Design

The RoboDog

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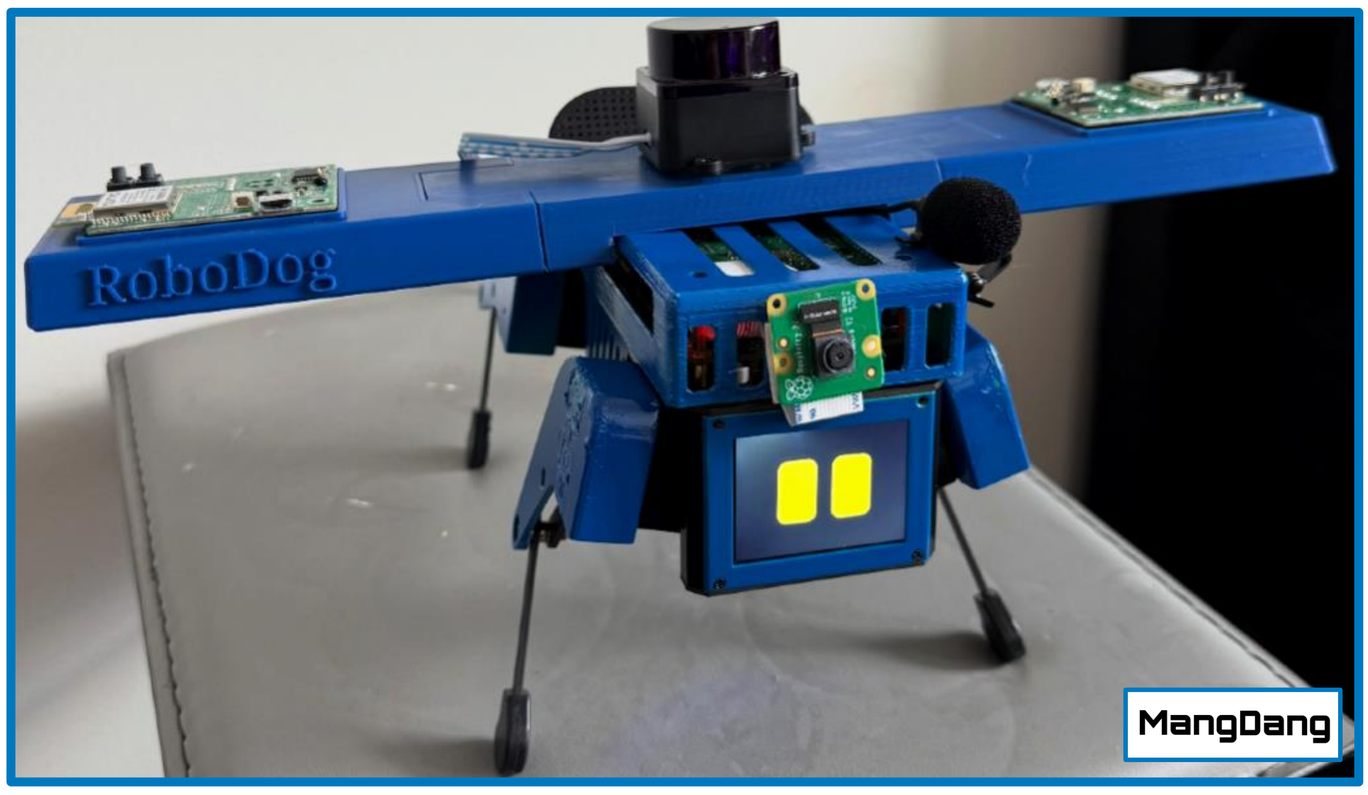
Big Picture

Overview:

We designed RoboDog, a low-cost, modular robotic quadruped enhanced with voice control, gesture recognition, UWB tracking, and LiDAR-based obstacle avoidance. Our system uses open-source hardware and a user-friendly Android app to provide a customizable platform for students, developers, and researchers. The design encourages experimentation and real-world application in areas such as education, personal robotics, and research.



Background / Market Context

The Need:

High-end robotic dogs like Boston Dynamics' Spot are cost-prohibitive, often exceeding $75,000. Our goal was to create an affordable solution that developers and hobbyists could afford and adapt to their own specific needs.

Market Opportunity:

The robotic dog market is projected to grow from $1.2B in 2023 to $4.8B by 2032. There is a clear need for affordable alternatives with high customization potential.

Marketing Requirements	Engineering Requirements
The Robodog must provide a versatile and accessible robotic companion platform that is affordable and customizable for developers, students, and engineers.	The Robodog shall maintain a UWB connection to the user within a maximum distance of 20 feet, dynamically adjusting its position based on the user's location.
The Robodog must offer intuitive gesture control, accurately recognizing and responding to user gestures for seamless interaction.	The Robodog shall recognize user gestures using camera sensors and execute corresponding commands within 4 seconds of gesture.
The Robodog must support voice-based action control, allowing users to issue voice commands for hands-free operation.	The Robodog shall accurately process user voice commands using a Large Language Model (LLM), executing corresponding actions within 5 seconds after the user finishes speaking.

Design Approach

- Voice Command Mode: Microphone + LLM + Speaker
- Gesture Control Mode: Real-time camera processing
- User Following Mode: UWB trilateration
- Obstacle Avoidance: LiDAR based avoidance system
- Mobile App: Toggles and customizes modes
- 3D-Printed Parts: Custom mounts for UWB anchors

Major Results

- Successfully implemented UWB user tracking with trilateration
- LiDAR-based obstacle avoidance in real time
- Gesture recognition mode responds in <1s
- Voice command mode responds with action and speech in <1s.
- Android app that toggles modes and adds custom functionality
- Custom 3D-printed parts for mounting and wearable design

Conclusions & Future Work

Conclusions

RoboDog offers an affordable, extensible robotic platform suitable for education, personal use, and research. It integrates modern AI tools with intuitive interfaces for a rich user experience. Its modular design allows for easy customization and future upgrades, making it adaptable to a wide range of user needs.

Future Work:

Expansion to the Android app to support real-time direction control with live streaming from the RoboDog's camera. Future updates can also enable person recognition, object detection, and user-defined gestures with customizable actions for a more personalized experience.