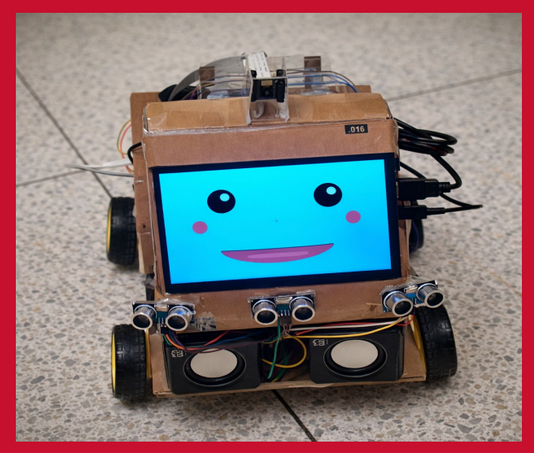
Iowa State University™

Department of Computer Science



Project Simple Robot: An Embedded AI Autonomous Exploration Robot

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Abstract

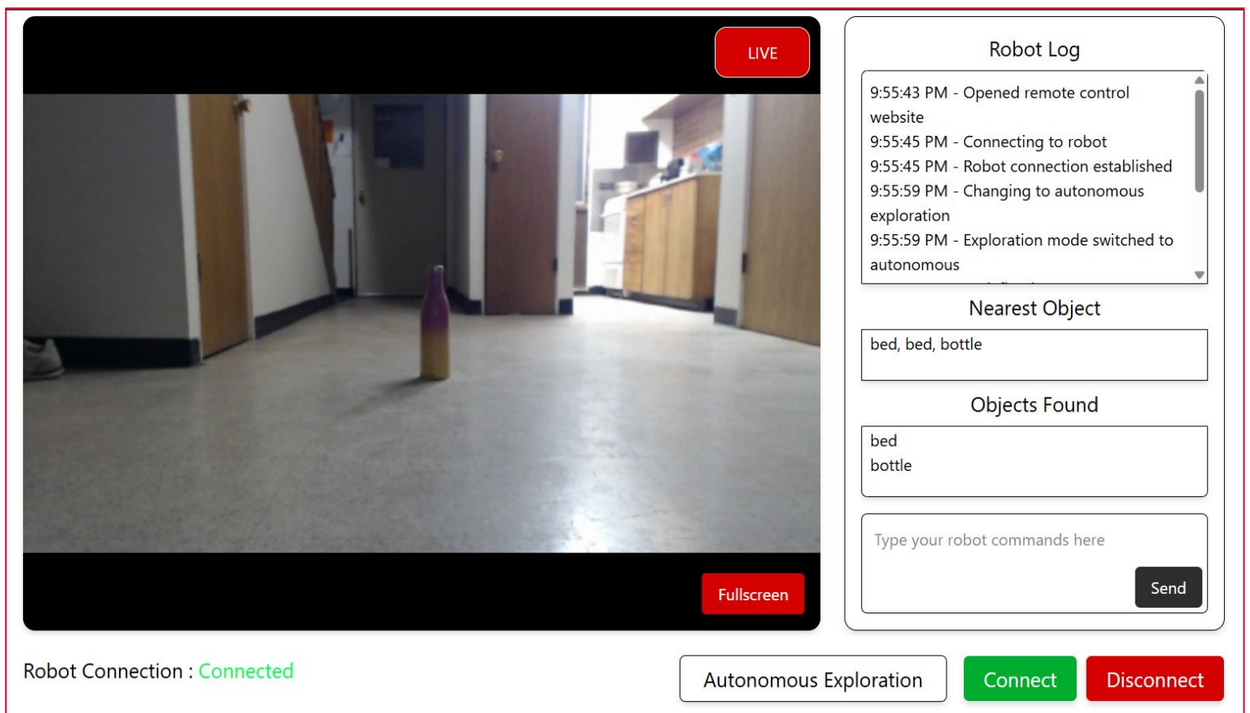
1.1 Objective: Develop an embedded AI robot capable of autonomous exploration, object identification, and natural-language interaction.

1.2 How was it done?: Traditional robotic navigation often relies on precise geometric coordinates, which can require substantial manual configuration and user involvement.

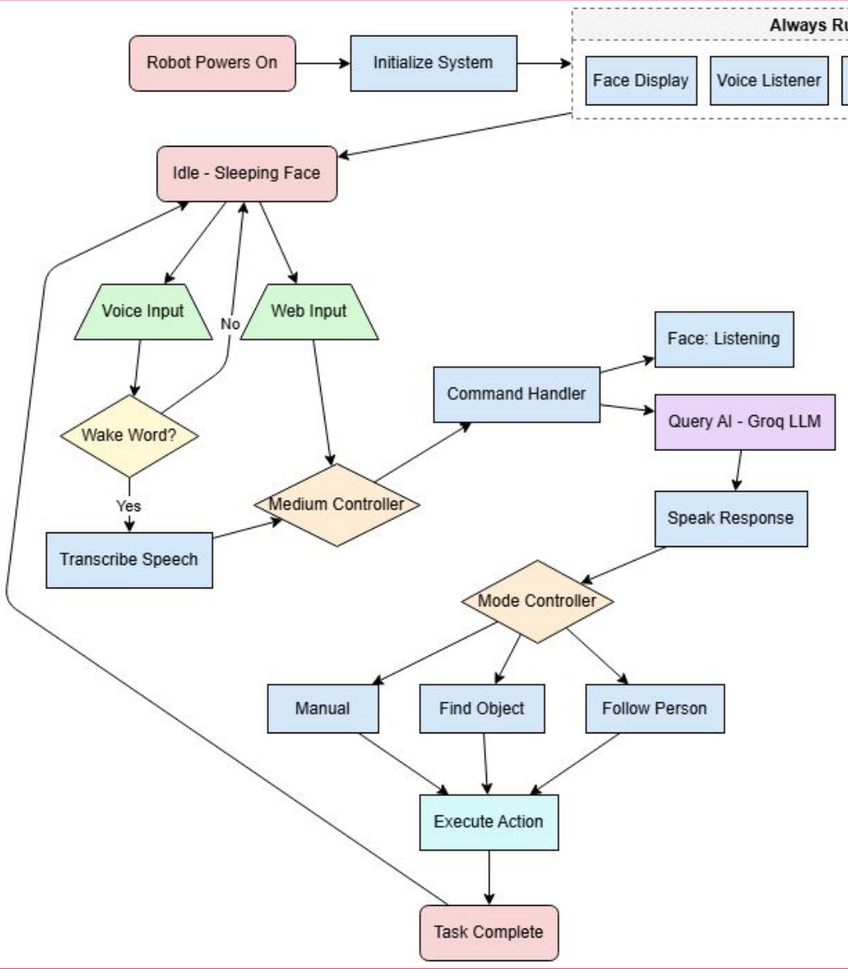
1.3 What's new?: Integrate object detection, large language models, speech-to-text, and text-to-speech systems to enable real-time interaction, partial localization, and decision-making.

1.4 Outcome: Simplifies the robotic environment mapping task by easing user interaction through intuitive, language-based control.

Remote Control Interface



Robot WorkFlow



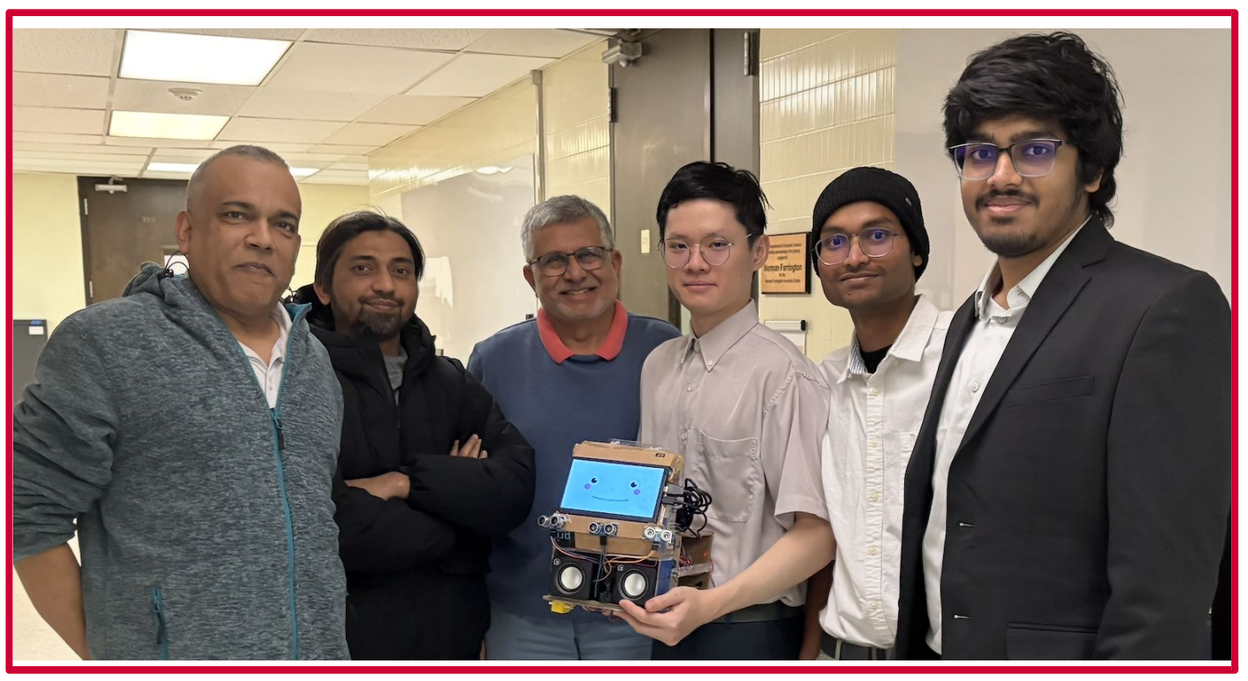
Results

- Autonomous Exploration in an unfamiliar environments
- Real time ultrasonic readings manipulation for collision prevention
- Natural language Interaction using Speech to Text (Whisper) and Text to Speech (Open AI TTS)
- Partial Environment Localization through visual cues analysed with YOLO v8, ultrasonic readings, and light movement history tracking.
- Website for remote control and live monitoring of robot actions.
- Successful detection and navigation toward user-requested objects in unknown environments.
- Robot follows a person on command using object detection models for horizontal and vertical movement input.

Limitations and Future Work

- Identical electrical pulses result in varying travel distances and turn angles, reducing the reliability of path history. Integrating an odometer and gyroscope would enable accurate measurement of distance traveled and rotation angles, reducing cumulative navigation error.
- Vision-based (Camera and Object detection model) localization performance degrades in low-light conditions. LiDAR integration would enable precise navigation in low-light environments.

Team and Mentors



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