Robots for Outreach

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ABSTRACT

Using Claflin University's robots, we will program them to support our outreach efforts in computer science. The goal is to engage potential students and visitors with our computer science department through interactive demonstrations. A series of programs has been developed to illustrate the importance and diversity of computer science using the NAO humanoid and Unitree Go2 robots. These activities aim to instill basic computer science principles such as sequencing, conditional statements, sensor-based decision-making, and human-robot interaction. During outreach events, the robots perform demonstrations to help participants see how code translates into physical actions, demystifying programming, and robotics. By providing an interactive and visually engaging experience, computer science can be made more accessible to individuals with varying levels of technical background. This project demonstrates how robotics can be an effective tool for computer science outreach, increasing engagement, encouraging curiosity, and fostering interest in computing disciplines.

1 Introduction

With the rise in computer science spreading into a multitude of career fields, there is a growing demand for computer literacy. By 2029, employment in computer and technology occupations is expected to grow 11%, creating over half a million new jobs [1]. This creates a gap between the current education and industry demands. As a result, it is crucial for children to be exposed to computer science topics as early as possible. However, it remains a challenge to gain students' enthusiasm who are not already interested in STEM (Science, Technology, Engineering, Mathematics). Computer science outreach has proven to address this problem, as it benefits students both short- and long-term. In a comprehensive review, Lakanen found that the students most impacted by outreach were the ones with the least programming experience [2]. Additionally, 41% of the students' found their conception of programming changed. Another study found that in-school outreach events reached a more diverse audience and positive attitudes toward science increased significantly through these events [3]. By giving students the chance to learn about computer science hands-on, instead of lecturing on the topic, the student is more likely to think positively of pursuing a STEM career [4]. Hands-on activities increase the students' self-efficacy, problem-solving, critical thinking, and memory retention, all beneficial skills for a computer science career.

2 Robotic Systems for Outreach

To support our outreach efforts, two interactive robots were selected: the NAO humanoid robot and the Unitree Go2 quadruped robot. These robots were chosen because they showcase different aspects of computer science while being visually engaging and accessible to a broader audience. Together, these robots provide complementary learning experiences. NAO emphasizes social interaction and communication, while Go2 highlights autonomous movement and physical computing, allowing participants to explore multiple dimensions of computer science through hands-on activities.

2.1 NAO Humanoid

NAO is a small humanoid robot equipped with articulated joints, cameras, microphones, touch sensors, and speech capabilities, allowing it to walk, gesture, speak, and respond to human interaction [5]. Its human-like appearance and conversational behaviors make it approachable for participants, helping reduce intimidation and encouraging engagement. NAO is particularly effective for demonstrating concepts related to human–robot interaction, sequencing, event-driven programming, and motion control.

The NAO humanoid is capable of far more, especially when programming is involved. Through Aldebaran Robotics' software, Choregraphe, NAO can be programmed to perform complex movements, speech, and interactive routines. One key feature that enables this functionality is joint stiffness control, often referred to as freeze joint programming. This technique allows specific joints to be locked in place by maintaining stiffness, preventing unwanted motion while other joints continue to move. By selectively freezing joints, programmers can create precise, stable, and coordinated movements, making complex behaviors and animations possible. Figure 1 illustrates this freeze joint programming within the

Choregraphe interface, highlighting how specific joints can be fixed to maintain stability during motion design. Each box in the timeline at the top of the screen corresponds to a joint that has been frozen to maintain a fixed position.

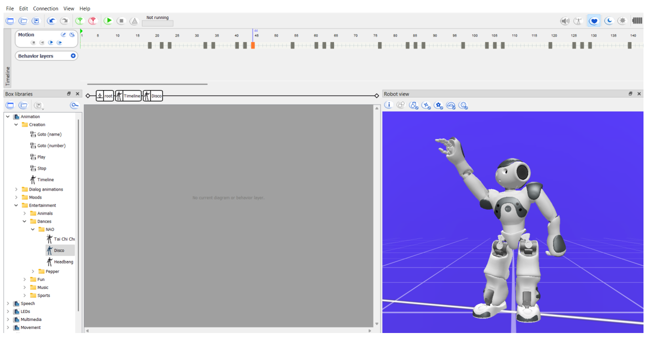

Figure 1: Choregraphe software interface showing the NAO humanoid with selected joints frozen to maintain a fixed pose during motion programming.

2.1 Unitree Go2 Quadruped Robot

In contrast to NAO's humanoid design, the Unitree Go2 is a four-legged mobile robot designed for dynamic movement and autonomous navigation. The Go2 is equipped with advanced sensors, including depth cameras, inertial measurement units, and obstacle-detection sensors, which allow it to perceive and respond to its environment in real time. The robot is programmed using its Robot Operating System (ROS), allowing custom motion sequences, AI algorithms, and sensor data processing [6]. The Unitree Go2 provides a valuable opportunity to introduce participants to core computer science topics such as path planning and feedback control. The Go2 can be trained to walk, trot, avoid obstacles, follow predetermined paths, or respond to environmental factors during our outreach events. Participants will see how algorithms and sensor data affect movement in the real world through these behaviors. By learning the two robots, participants can gain a better understanding of how various robot configurations impact hardware and software design choices. Demonstrating that computer science concepts can be applied to different platforms, even when the robot's physical form differs significantly. Figure 2 provides a visualization of the Unitree Go2's sensor-based perception, showing how environmental data is processed for navigation and obstacle detection.

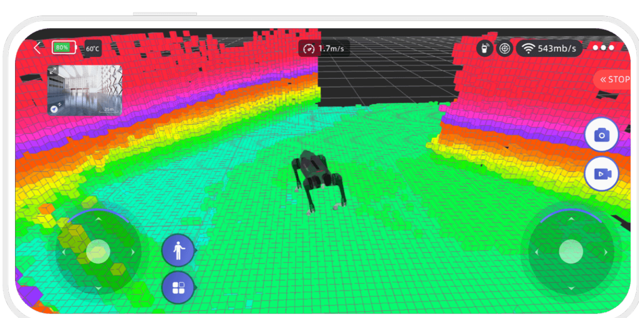

Figure 2: Visualization from the Unitree Go2 showing how onboard depth sensors map the surrounding environment to support obstacle detection and autonomous movement.

3 Implementation and Outreach Design

Our outreach events will v take place in a variety of settings, including K–12 school visits, campus tours, summer camps, and community STEM events. Each session is designed to be portable and adaptable to the audience size and age range. The setup will include a presentation area where both robots can safely operate, a display showing the programming interface, and facilitators guide participants through the demonstration. Screenshots, timelines, and simplified flow diagrams are used to visually connect robot behavior to programming logic.

3.1 NAO Outreach Flow

NAO demonstrations are structured to emphasize interaction and decision-based execution. Programs are designed around a clear input–processing–output model that can be easily explained to participants. A typical NAO outreach interaction follows these steps:

1. The robot initiates interaction with a greeting

2. A question prompt is issued

3. The system waits for user input via speech or touch sensors

4. A conditional branch determines the next action

5. The robot executes a motion sequence or routine

Participants first observe the full demonstration. Next, facilitators explain the underlying logic using visual programming blocks and timelines. In some sessions, participants are allowed to modify simple parameters, such as motion timing or response selection, and then run the program to observe the effects of their changes.

3.2 Unitree Go2 Outreach Flow

Unitree Go2 demonstrations may vary depending on the outreach setting and audience. In addition to autonomous behaviors programmed through the Unitree software development kit, Go2 can also be controlled using the Unitree application and a handheld remote controller. This allows facilitators to switch between preprogrammed autonomy, direct operation, and environment reactive behaviors. By combining manual control with sensor responses, participants can observe how different control strategies influence robot behavior and decision-making in real time.

3.3 Participant Experience

Each outreach session follows a consistent learning progression. Participants begin by observing a complete demonstration, followed by a guided explanation of the program structure. When appropriate, participants interact directly with the robots by modifying simple code elements or initiating behaviors themselves. This step-by-step approach allows participants to see how programming logic translates into physical action, reinforcing fundamental computer science concepts such as sequencing, conditionals, and loops without requiring prior programming experience.

4 Discussion

Using multiple robotic platforms allows outreach participants to explore different dimensions of computer science. NAO emphasizes social interaction, communication, and behavior sequencing, while the Unitree Go2 highlights autonomy, physical computing, and environmental interaction. Together, these robots provide a comprehensive introduction to the range of computer science and robotics. These outreach efforts are expected to increase engagement, improve attitudes toward computing, and encourage students, particularly those with limited prior exposure, to consider computer science as a field of study. By providing hands-on, visually compelling experiences, using robots for our outreach can help reduce intimidation and foster curiosity, confidence, and sustained interest in computing disciplines.

5 Conclusion

This project demonstrates how programmable robots can serve as effective tools for computer science outreach. By leveraging the interactive capabilities of the NAO humanoid and the dynamic mobility of the Unitree Go2, outreach events can engage diverse audiences and clearly illustrate how code translates into real-world behavior. These activities not only introduce foundational computer science concepts but also promote positive perceptions of computing as an accessible and creative discipline. Future work will focus on expanding outreach programs, incorporating participant feedback, and assessing long-term impacts on student interest and academic pathways in computer science.

CCS CONCEPTS

• Human-robot interaction • Robotics • Computing education programs

KEYWORDS

Computer science outreach, educational robotics, NAO humanoid, Unitree Go2, STEM education

ACM Reference format:

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†Author Footnote to be captured as Author Note

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