Semi-Autonomous Control of mBot Neo Robots Using Physiological Signals and PID Systems

I. Introduction

The integration of robotics and physiological signals has become a expanding area of research, offering promising opportunities for enhancing human-robot interaction. In this context, the current study was undertaken as part of a Research Experience for Undergraduates (REU) program at the University of Alabama. The objective was to advance the capabilities of Makeblock's mbot neo robots by developing a semiautonomous control system that incorporated both physiological controls and advanced programming techniques.

II. PID-Based Control System Development

The initial phase of the research focused on implementing a PID (Proportional-Integral-Derivative) control system for the mbot neo robots. This was achieved through the use of a block-based programming interface, which provided a user-friendly platform for developing and testing the PID algorithm. The PID control system was meticulously designed to empower the mbot neo robots with a high degree of precision in responding to both user commands and external stimuli from their environment. By integrating the PID algorithm, the robots gained the ability to continuously analyze their current state, compare it to the desired state, and generate control signals to correct any discrepancies. This level of responsiveness translated into smoother and more accurate robot movements, contributing to a seamless interaction experience for users.

III. Transition to Python-Based Control

Recognizing the limitations of the block-based programming interface, the research team transitioned the control system to a Python-based environment. This shift provided several advantages, including greater flexibility in algorithm design, more comprehensive debugging capabilities, and the ability to leverage thirdparty libraries for enhanced functionalities. The migration to Python also facilitated the integration of physiological control.

The incorporation of physiological controls aimed to enhance the robot's responsiveness to user emotions and intentions. Initially, the research team explored the utilization of Emotibits, a physiological signal monitoring device, to capture emotional fluctuations in real-time. However, after careful evaluation, Electrodermal Activity (EDA) emerged as the preferred physiological metric due to its sensitivity to emotional changes.

IV. Electrodermal Activity (EDA) and Emotional Interpretation

EDA sensors were integrated into the control system using the Emotibit, enabling the collection of physiological data correlated with emotional states. Python code was developed to process and visualize the EDA data, allowing for the real-time interpretation of the user's emotional responses during interactions with the robot. This innovative approach opened avenues for dynamic adaptation of the robot's behavior based on the user's emotional cues.

One of the key milestones achieved in the research was the successful implementation of semiautonomous behaviors for the mbot neo robots. Leveraging the PID control system, the robots were programmed to navigate autonomously while following walls and avoiding obstacles. This advancement in autonomy marked a significant step towards creating robots capable of intelligently interacting with their environment.

V. Conclusion

In conclusion, this paper highlights the evolution of the mbot neo robot control system from its initial PID-based programming to the incorporation of physiological controls and the development of semiautonomous behaviors. The transition from a blockbased programming interface to Python underscored the importance of adaptability and flexibility in robotics research. The integration of physiological controls introduced a novel dimension to human-robot interaction, paving the way for emotionally responsive robots that can adapt to user emotional states. This research not only demonstrates technical competence in programming and robotics but also emphasizes the interdisciplinary nature of modern robotics research and its potential to shape the future of human-robot collaboration. While we didn’t have time to finish the integration of using our Emotibit code to change the Mbot semi-autonomously we successful where able to make both the autonomous controls and the EDA reader to an updating list.