Adaptive Learning in Motion: Harnessing Cloud-Based AI for a Smart Soccer Ball's Real-Time Navigation

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Abstract

This project aims to develop a Smart Soccer Ball, a compact, autonomous system that utilizes reinforcement learning, real-time sensor technology, and cloud-based AI platforms to navigate dynamic environments. Leveraging AWS SageMaker for RL model training and SimSpace Weaver for scalable 3D simulations, the soccer ball will be trained to adapt to both static and dynamic obstacles within a puzzle maze. The project will be conducted in two phases: Phase 1 focuses on developing a Minimum Viable Product with basic maze navigation and static obstacles, while Phase 2 (contingent on efficient progress) will explore advanced RL techniques, dynamic environments, and sophisticated sensors for complex obstacle handling. This endeavor provides an opportunity for hands-on AI and robotics experience, offering insights into low-cost, adaptable autonomous systems and smart sports technology. By demonstrating adaptive, real-time decision-making in a compact device, the project highlights the potential of applying advanced AI to sensor-driven robotics.

Keywords: smart soccer ball, reinforcement learning, AWS SageMaker, autonomous navigation, adaptive robotics, dynamic environments

1. INTRODUCTION

Problem to Solve

One of the key challenges we face is navigating dynamic environments with an autonomous system. Although autonomous navigation has been explored in various fields, it remains complex when environments constantly change. Reinforcement learning (RL) models, though powerful, often struggle to generalize across varying conditions and adjust to real-time changes (Kober et al., 2013). Traditional RL approaches, which rely heavily on trial and error, can be inefficient in unpredictable environments.

This is where model-based reinforcement learning (MBRL) steps in, enhancing decision-making by allowing systems to anticipate and adapt to changes. MBRL has proven effective in sensor-driven robotics, addressing real-time navigation challenges (Polydoros & Nalpantidis, 2017). By incorporating MBRL, we aim to improve the adaptability and efficiency of the Smart Soccer Ball, enabling it to tackle both static and dynamic obstacles.

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