Proposal for Robotics Simulator Development

Project Overview:

This proposal outlines the development of an FTC Robotics Simulator designed to provide a realistic, immersive environment for robotics teams to test their robotic designs, strategies, and autonomous code. The simulator will replicate a 1:1 scaled game field, accurately simulate robot behavior, and support various input methods, including VR integration and gamepad controls.

Base Features:

These features will be prioritized as they make the core of the simulator.

1. Game Field

* 1:1 Scaled Environment:
  + The simulation will feature a game field scaled accurately to real-world dimensions, ensuring that the environment is true to life.
* Functional Components:
  + All field components (goals, obstacles, etc.) will be fully interactive and behave as they would in a physical setting.
  + Unity’s physics engine will be implemented and modified to accurately simulate the movement, collisions, and interactions of all objects on the field.
    - The physics simulation is an important aspect of the project and should closely replicate real-world behavior.

1. Robot Simulation

* Mecanum Wheels:
  + The robot's mecanum wheels will be meticulously simulated to replicate their unique omnidirectional movement capabilities.
  + To ensure realistic movement, the simulation will account for various factors, including friction, motor power, and wheel slippage.
* Robot Dynamics:
  + The robot's speed and behavior will be modeled based on real-world factors such as weight, motor specifications, and gear ratios.
  + A customizable physics model will allow users to adjust parameters to match their specific robot design.
* Gamepad Controller Integration:
  + Users will be able to connect their gamepad controllers to the simulator, allowing for intuitive control of the robot.
  + A control mapping feature will enable users to assign functions to specific buttons and joysticks, providing a customizable experience.

Additional Features:

These are features that will be added once all if not most of the core features are added. These features are not entirely necessary for the simulation to run accurately but will help enhance the simulation quite a bit.

1. VR Integration

* Logitech Controller for VR Input:
  + The simulator will support VR experiences by integrating the Logitech controller as the primary input device.
  + The VR environment will be optimized for smooth interaction, providing a seamless and immersive experience.
* Smooth VR Experience:
  + The simulation will be optimized for VR, ensuring low latency and high frame rates to avoid motion sickness and ensure a comfortable experience.
  + Techniques such as foveated rendering may be implemented to enhance performance without sacrificing visual quality.
    - Foveated rendering is a technique used in virtual reality (VR) and other graphics-intensive applications to optimize rendering performance. It leverages the fact that the human eye has high visual acuity only in a small central area called the fovea, while peripheral vision is much less detailed.

1. Autonomous Programming

* Autonomous Program Execution:
  + The simulator will allow users to run autonomous programs within the environment, providing a platform for testing and refining strategies.
  + Inspired by the Meep Meep code, this simulator will be able to have code directly run onto it to optimize compatibility.
  + The autonomous mode will feature a high degree of accuracy, with minimal adjustments required when transferring programs from the simulator to real-life robots.
* Accurate Simulation Environment:
  + The physics and environment will be finely tuned to match real-world conditions, ensuring that autonomous routines perform similarly in both simulated and physical settings.
    - This will include tile sink and battery usage to keep this simulation as realistic as possible.

Technical Specifications:

Physics Engine:

* The simulator will utilize Unity to simulate the dynamics of the robot and field elements.

Graphics and User Interface:

* The simulator will feature high-quality graphics to provide a realistic visual representation of the robot and field.
* An intuitive user interface will allow users to easily navigate the simulator, adjust settings, and switch between manual and autonomous modes.

Performance Optimization:

* The simulator will be optimized for performance, ensuring smooth operation even with complex physics calculations and VR integration.

Conclusion:

This Robotics Simulator aims to provide a highly realistic and customizable platform for testing and refining robotic designs and strategies. With advanced features such as VR integration and autonomous programming, this simulator will be a valuable tool for robotics teams and enthusiasts.