Design, Development, and Performance Analysis of a Quadruped Robot for Educational and Industrial Application

S.A. De Silva* and A.R.P.C.C.J. Amarasinghe

Uva Wellassa University, Badulla, Sri Lanka

**shaundesilva1999@gmail.com*

Abstract

This project details the design, development, and evaluation of the Dingo quadruped robot, with a focus on educational applications and small-scale automation tasks. The robot integrates mechanical, electronic, and control systems to achieve dynamic and stable locomotion across diverse terrains. A custom gait control algorithm based on inverse kinematics ensures smooth leg coordination. The control system takes input from a 9-axis IMU sensor, continuously monitoring orientation and movement to correct joint angles and maintain stability and controllability during operation. The robot is primarily programmed in Python, leveraging the ROS Noetic framework for communication and control. High-level control is managed by a Raspberry Pi 4B, while an Arduino Nano processes sensor data, including voltage and temperature monitors, to optimize motor control and energy management. The quadruped uses DS3240 digital servos for precise leg movements, allowing traversal of uneven terrains with balance and stability. Sensors enhance the robot's adaptability, making it suitable for tasks requiring flexibility. Applications range from educational robotics, providing a platform for learning control systems, to small-scale automation in fields like agriculture, inspection, and exploration. The Dingo quadruped is designed as a research platform, offering potential for future improvements. Enhanced autonomy through AI-based algorithms and machine learning could improve decision-making. Energy efficiency can be optimized with energy-efficient motors, low-power sensors, and improved power management systems. Advanced sensor integration, including LIDAR or stereo cameras, and force sensors will enhance environmental awareness and stability. Further control system enhancements will improve gait and navigation. This project builds on the foundational work provided by the original developers of the Dingo Quadruped platform.

Keywords: *quadruped robot, gait control, inverse kinematics, Raspberry Pi 4B, Python, ROS Noetic.*