Analysis of Quadruped Robot Locomotion Using LEGO Mindstorms Kit

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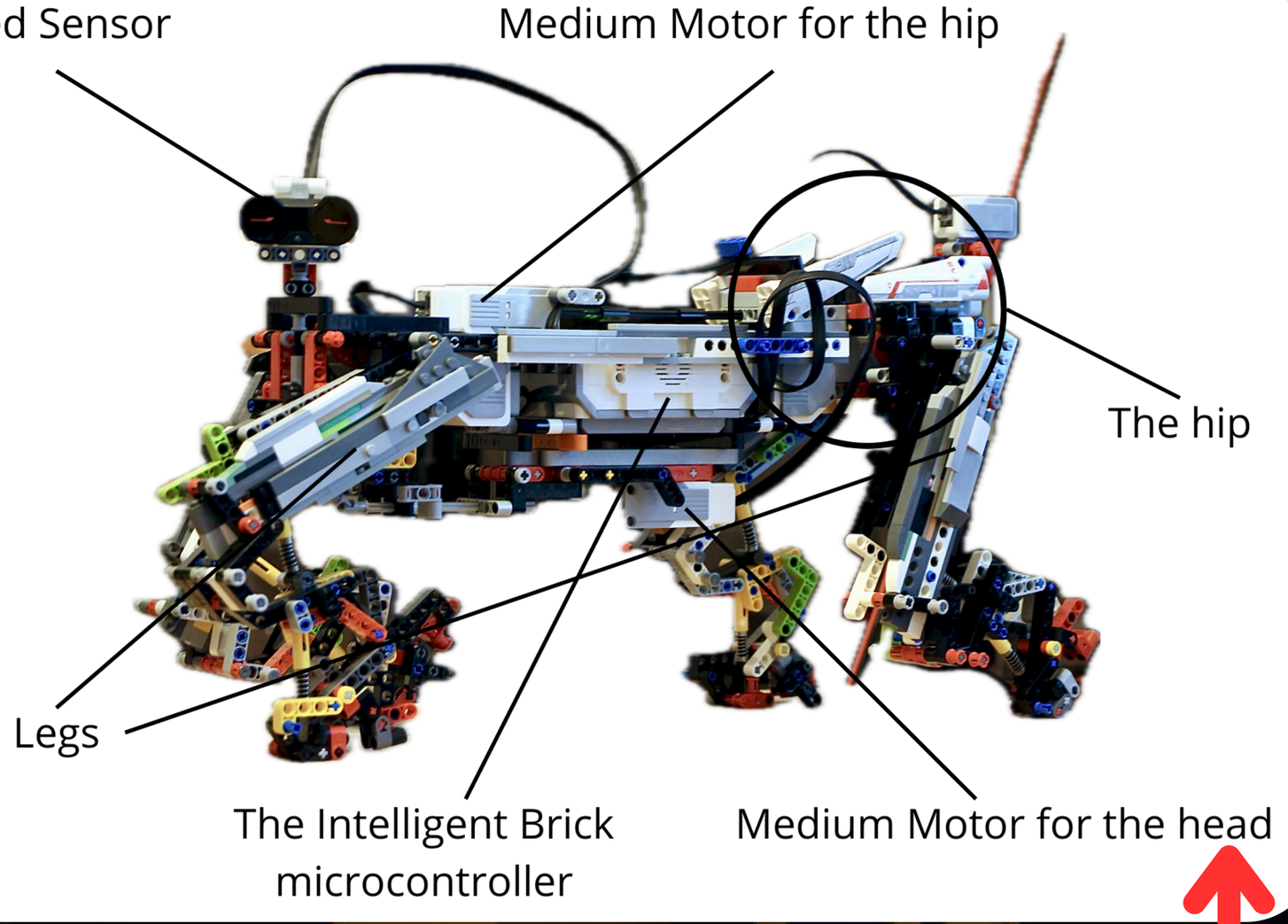
Introduction

My interest in the Boston Dynamics Spot robot dog inspired me to create my own programmable robot. The LEGO system provided an ideal foundation for easy modeling and versatile solutions.

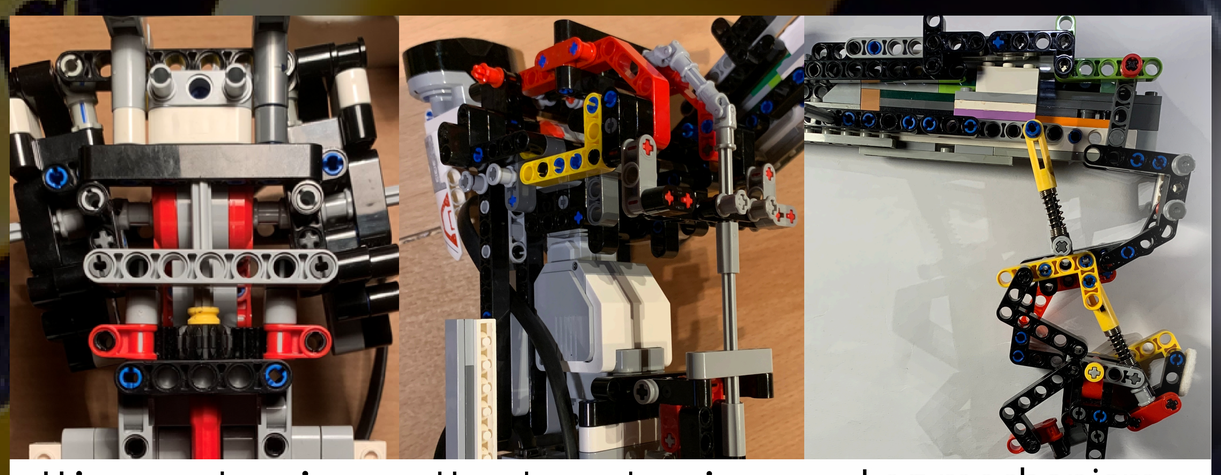
Aims

My research aimed to develop a four-legged LEGO robot with stable walking, programmed in Python. I optimized the movement by specializing the legs and implemented both remote and voice control to maximize available tools.



Methods and Materials

Mechanisms

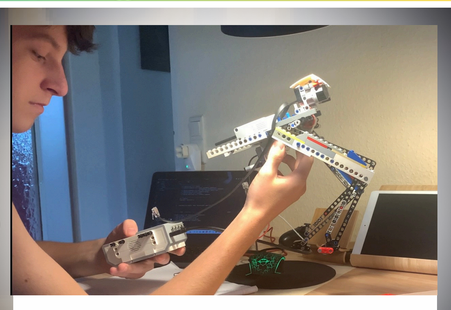

Hip mechanism

Head mechanism

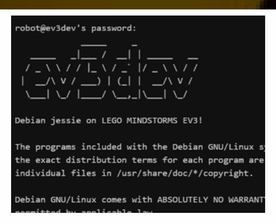
Leg mechanism

Developing


Information gathering and analizing the motion


Building prototypes

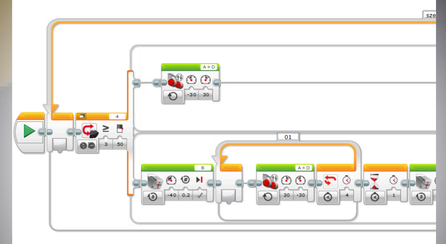
Mindstorms EV3

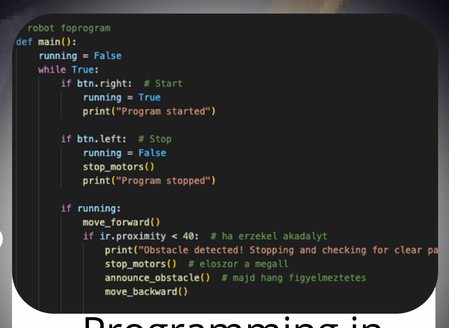


ev3dev


Visual Studio Code

Resources


Testing in EV3 home

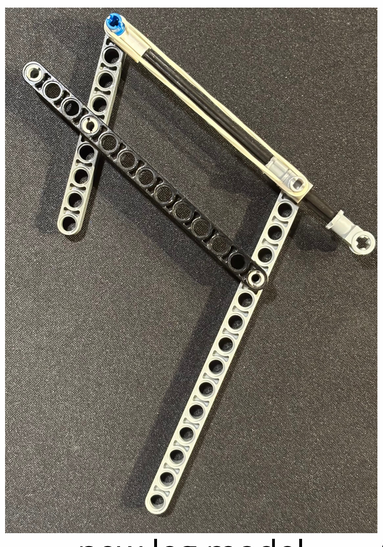


Programming in python

Improving,refining the model

Future development

Each leg will be powered by a separate motor, requiring a platform switch due to port limitations. The legs will be redesigned for higher load capacity, replacing LEGO parts with 3D-printed components. The robot will adapt to different surfaces and autonomously select the optimal movement. A gyro sensor will be integrated to enhance stability with the additional motors.


new leg model

Results

The robot achieved stable walking on flat terrain and gentle slopes using only two propulsion motors. Its fixed-centered body prevents lateral weight shifting, so complex legs with shock absorbers were designed for stability. The hip and head mechanisms, combined with control programs, enable autonomous obstacle avoidance, manual remote control, and voice control, supporting testing and optimization of different operating modes.

Testing results

Measurements showed that adding more shock absorbers reduced the leg lift from the ground. The efficiency of forward and backward movement depended on the position of the grip material on the foot. By changing a few parts, the complex leg could easily be adapted for tasks like climbing or improving movement in either direction. When the grip was placed in the center of the foot, forward and backward walking were equally effective. If placed off-center, the robot moved efficiently in one direction but slipped in the other.