3D Printed Robotic Dog Controlled by Arduino

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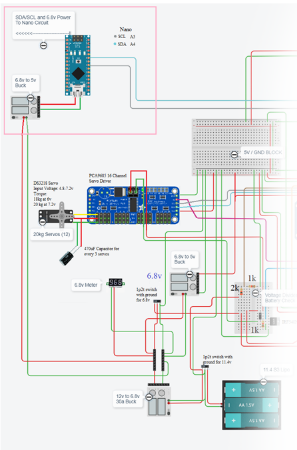
Introduction

- 3D Printed
- Power by 12v battery
- Arduino
- Walk on 4 legs
- Remote control by radio
- Preset movements
- Inverse Kinematics

Electrical Circuits



- 3S Lipo Battery
- LM2596 Buck Converter
- ACS712 Current Sensor
- AMS1117 Regular
- nrf24l01 Radio Transceiver
- PCA9685 Servo Driver
- MPU6050 Accelerometer

Mathematics

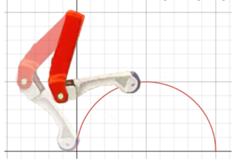
Inverse Kinematics

- Consists of 2 servo motors per limb
- Control the angle of Femur and Tibia in real time
- Motor angle depends on end-effector positions

1. Circle Formula

The x and y position of the foot will follow a semi-circular path, which can be calculated by using the circle formula

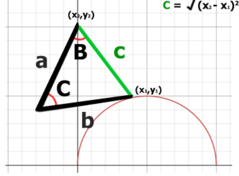
$$(x - 5)^2 + y^2 = 25$$



2. Distance Formula

Once the position is calculated, we can use the distance formula to get the length of side C

$$C = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

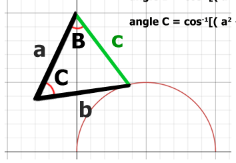


3. Law of Cosine

Since we already knew the length of a and b, we can use the Law of Cosine to find angle B and angle C

$$\text{angle } B = \cos^{-1}[(a^2 + c^2 - b^2)/2ab]$$

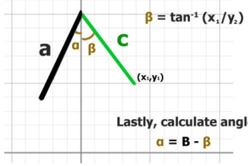
$$\text{angle } C = \cos^{-1}[(a^2 + b^2 - c^2)/2ab]$$



4. Trig. Functions

Split angle B into two angles, angle α and β
Use the x and y position of the foot and Tangent Function to find angle β

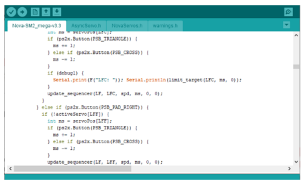
$$\beta = \tan^{-1} (x_1 / y_2)$$



Lastly, calculate angle α

$$\alpha = B - \beta$$

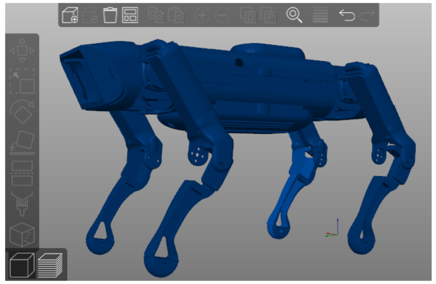
Coding



Arduino, C++

- Calculating angles in real time
- Room for adjustment
- 2 different scripts for sensors and motion
- 3/4 delay between front and back limbs

3D Printing



Ender 3
PLA (Body)
PETG (Foot)
PrusaSlicer
Various infill

Acknowledgements

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Reference

https://www.mathworks.com/discovery/inverse-kinematics.html
https://www.sciencedirect.com/topics/engineering/inverse-kinematics
https://www.rosroboticslearning.com/inverse-kinematics
https://oscarliang.com/inverse-kinematics-and-trigonometry-basics/