山东大学

崇新学堂

2024－2025 学年第一学期

实 验 报 告

课程名称: EECS

实验名称: Designlab08

专 业 班 级 崇新 23

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实 验 时 间 2024/11/22

Goals

Design Lab 8 focuses on designing and demonstrating circuits to control the speed of a motor. It builds on the model of the motor presented in Homework 2 and the proportional controller studied in Design Lab 6 (and earlier), culminating in a simple feedback system which steers the motor in the robot head to point its photoresistive eyes toward an incident light source.

• Characterizing the Lego motor used in the robot head
• Buffering the voltage used to drive the motor, using an op-amp
• Designing a simple bi-directional speed controller
• Demonstrating a feedback system to turn the robot head towards light, using a robot brain to control the motor

Step1 Minimum voltage required to turn

Adjusting the power supply voltage starting from 0V, it is observed that the motor starts rotating when the power supply voltage reaches 0.38V. Therefore, the minimum voltage to make the motor turn is 0.38V.

Fig 1 Minimum voltage

Step2 Resistance

Measure the resistance by using a multimeter: 5.4Ω

Fig 2 Resistance

Step3 First try

1.Build the circuit on our proto board. Turn the power supply back on and measure the voltage across the motor and observe the motor's behavior.

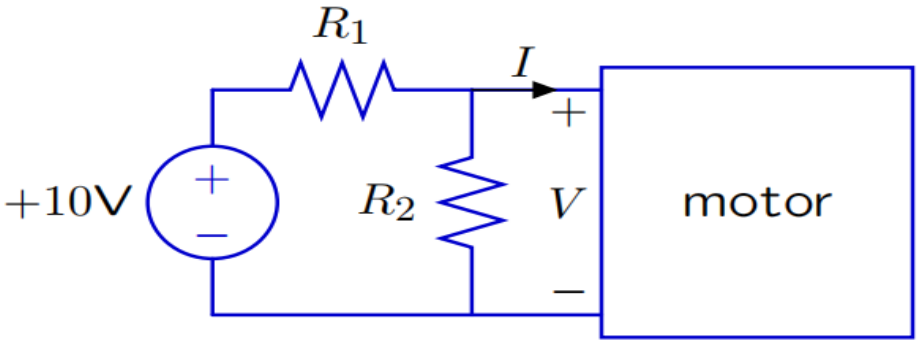

Fig 3 circuit

2. Measurement value = 44.6mV

Fig 4 Measurement value

Check Yourself 1

The motor did not turn because the motor is in parallel with a 1kΩ resistor, and this parallel combination results in a very small voltage drop, causing the voltage obtained by the motor to be far below its rotation threshold voltage of 0.38V (specifically, 44.6mV lower than the threshold voltage), thus failing to drive the motor to turn.

Step4 voltage value

Calculated voltage value = 53.42mV

Check Yourself 2

The measured value is approximately the same as the calculated value. Therefore, the aforementioned judgment can be regarded as correct.

Step5 simulation

The simulation circuit diagram is shown below：

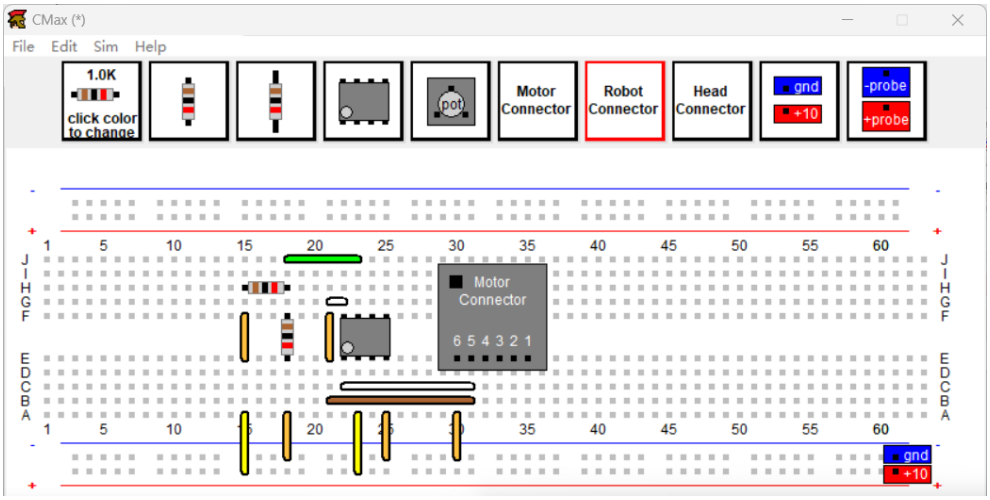

Fig 5 simulation circuit

The motor rotation angle diagram is as follows:

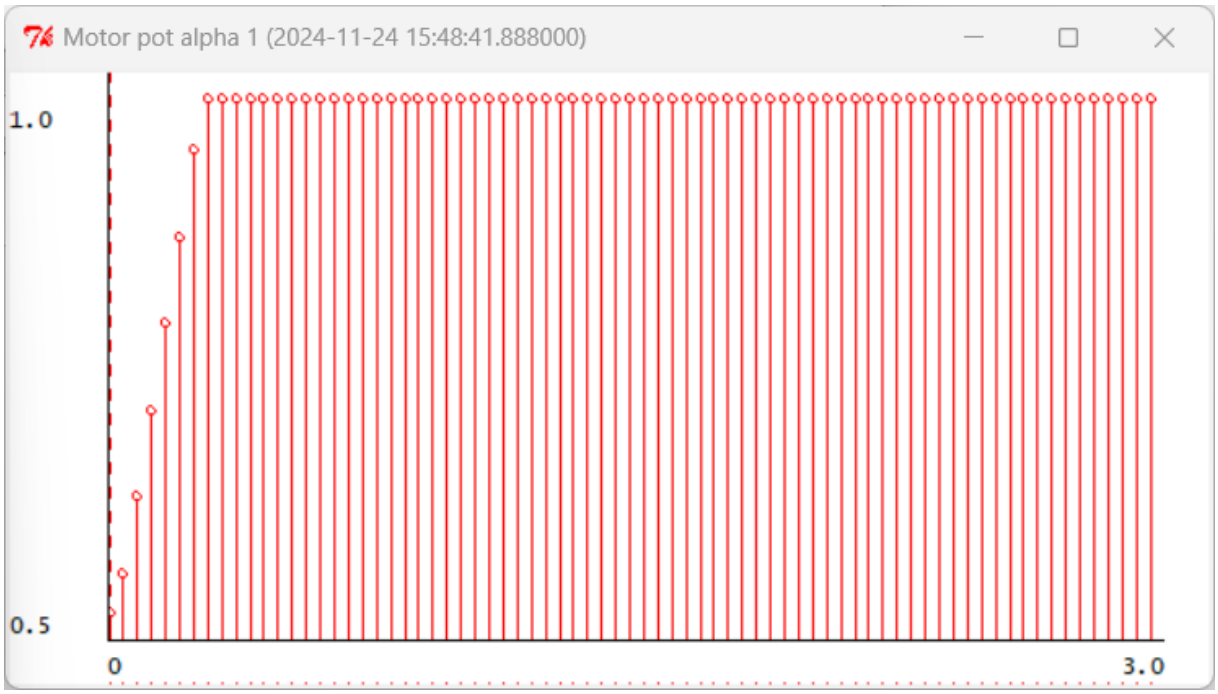

Fig 6 angle

The motor speed chart is as follows:

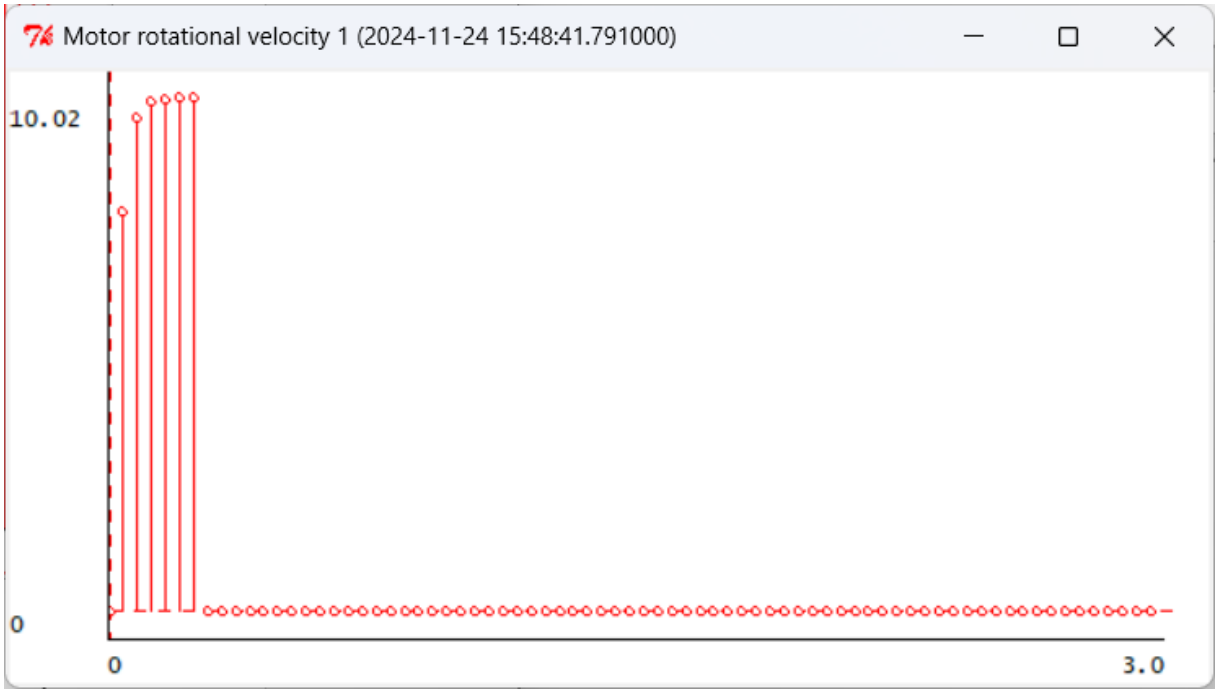

Fig 7 speed

Step6 ground try

Build buffered divider circui and observe the motor behavior: the motor turned

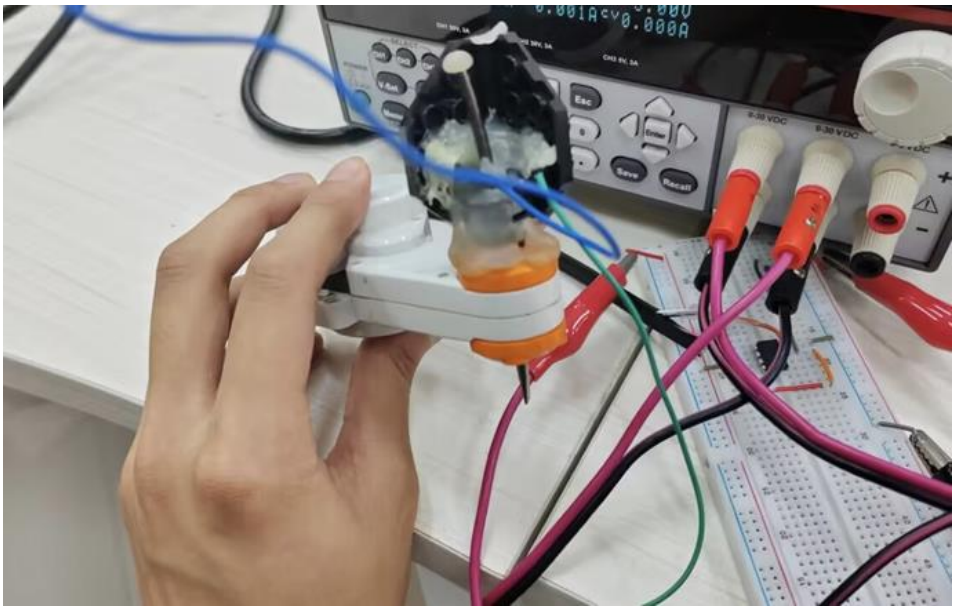

Fig 7 try

Check Yourself 3

A motor with a buffer circuit can turn, but without a buffer circuit, the motor cannot turn

Step7 simulation

The simulation circuit diagram is shown below：

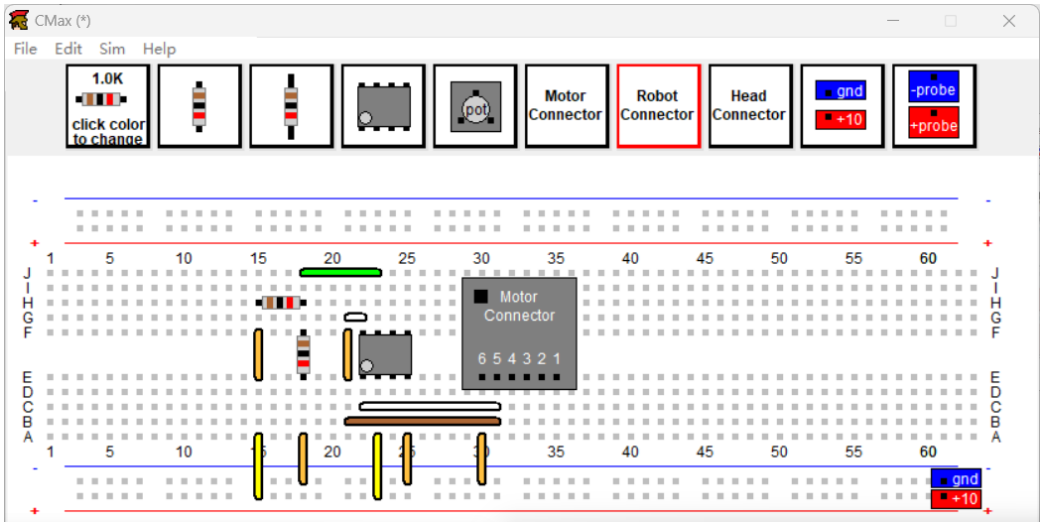

Fig 5 simulation circuit

potentiometer α value：

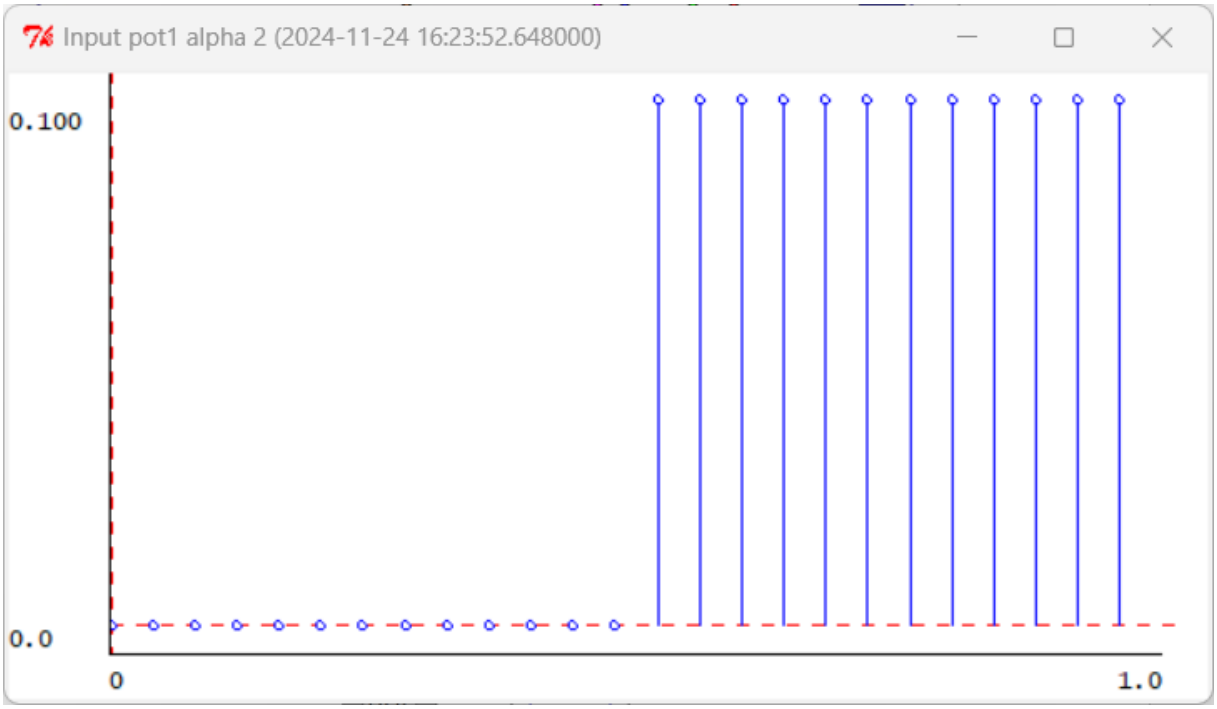

Fig 6 α

Motor angle：

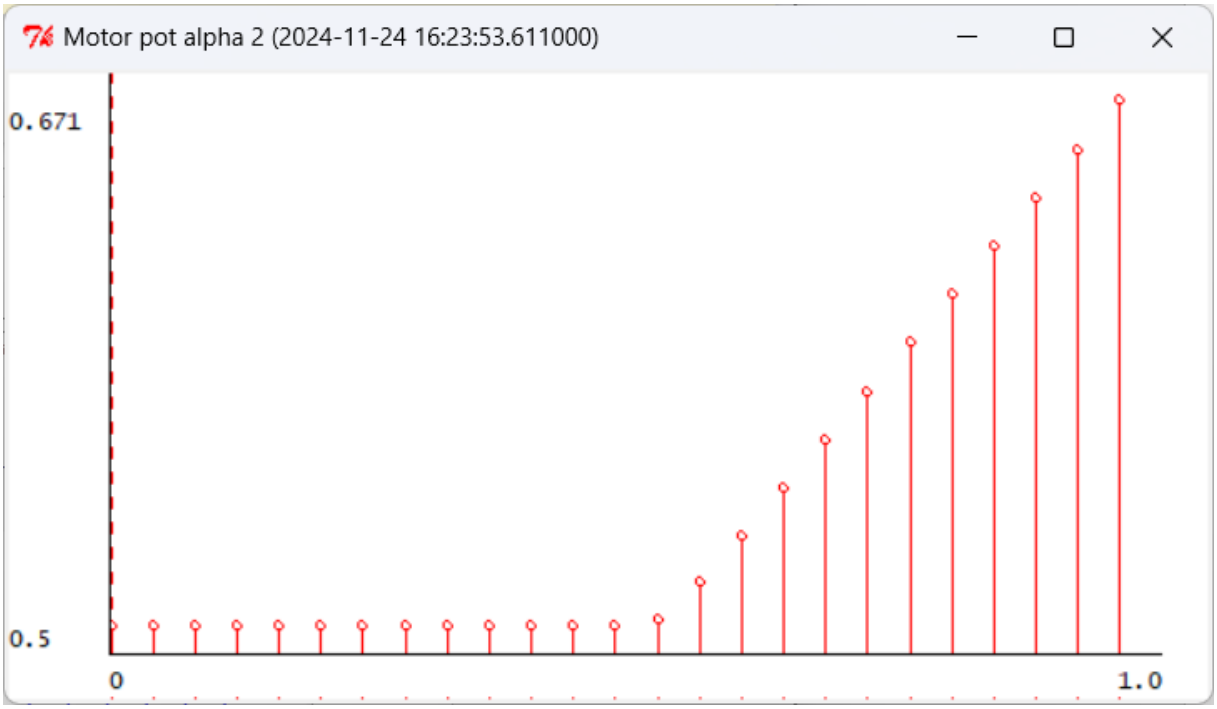

Fig 7 angle

Motor speed:

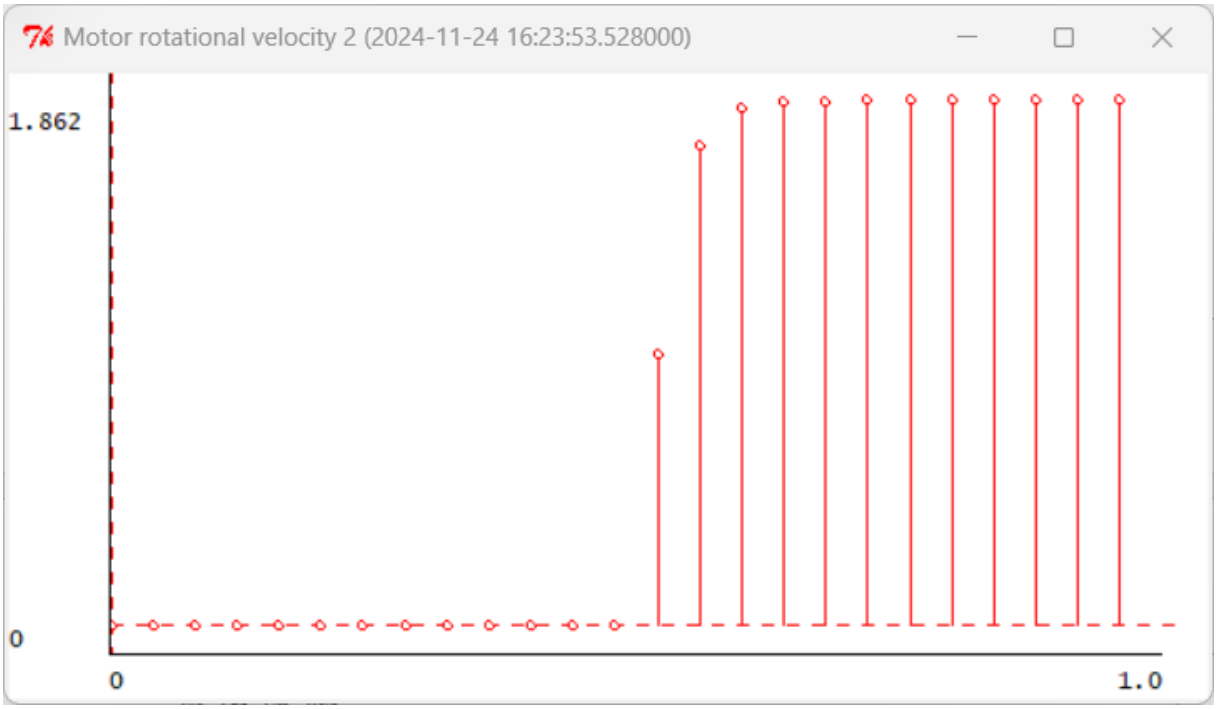

Fig 8 speed

Step8 ground try

Use a potentiometer circuit to drive a motor

Fig 9 ground try

Checkoff1

Both simulation and actual operation can only run normally with buffer

Step9

Vx=5V

Check Yourself 5

circuit is as follows:

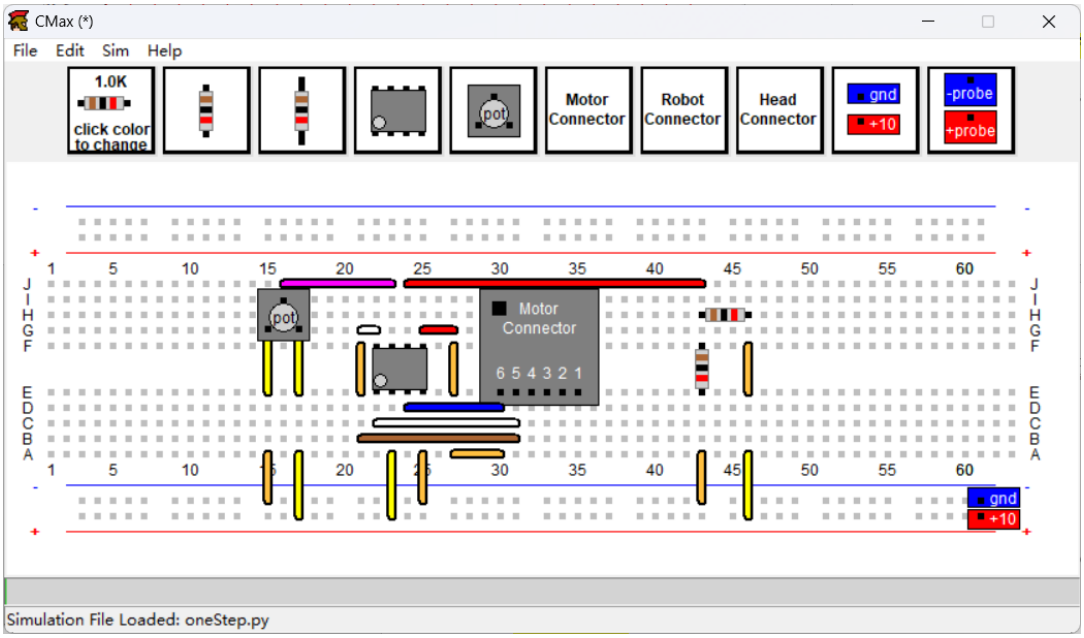

Fig 10 design circuit

Step10

Angle

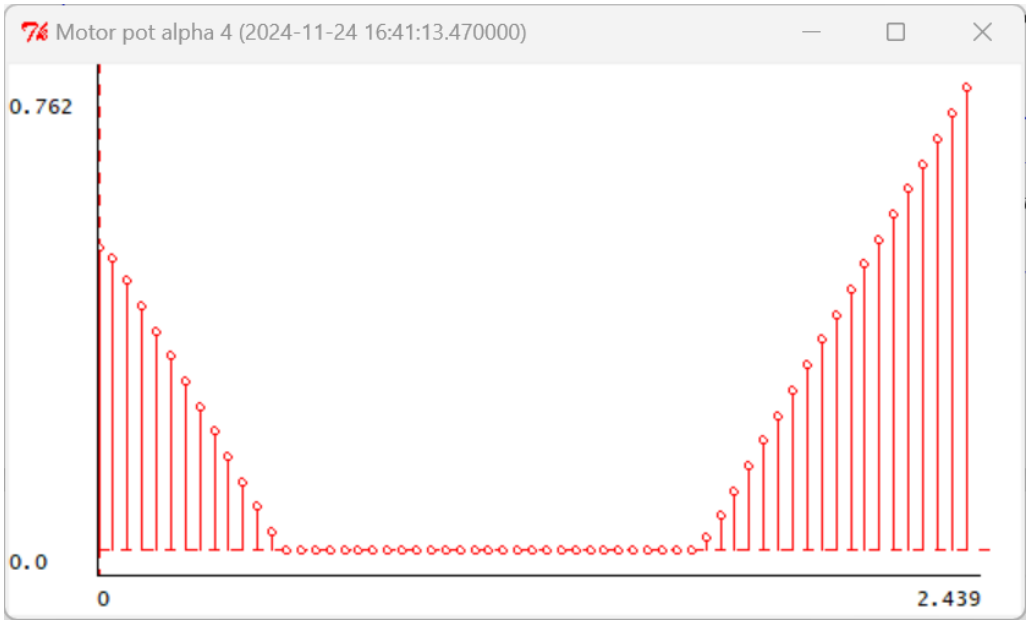

Fig 11 angle

Potentiometer α Value:

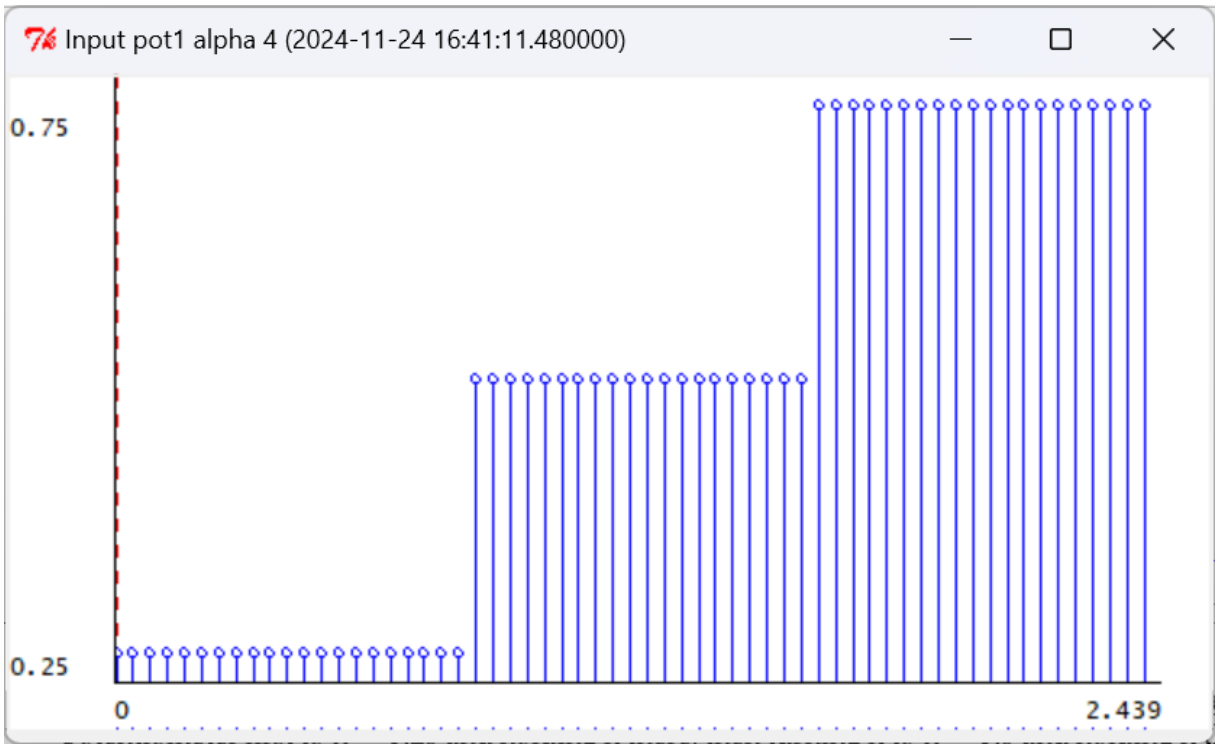

Fig 12 α

Speed

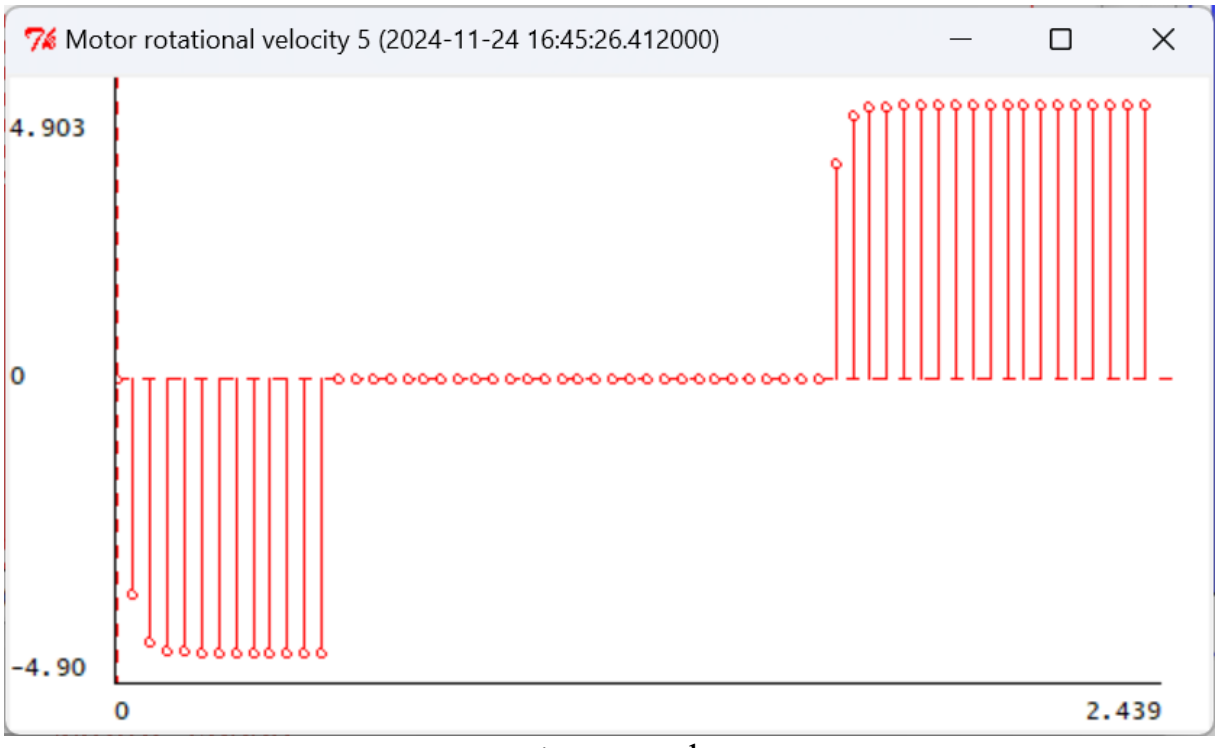

Fig 13 speed

Summary

This experiment aims to thoroughly investigate the rotation characteristics of the motor and its voltage requirements by adjusting the power supply voltage gradually starting from 0V. During the experiment, a crucial finding is that the minimum voltage required for the motor to start rotating is 0.38V, which determines the baseline voltage for the motor's activation. After measuring with a multimeter, the resistance of the motor is found to be 5.4Ω and the voltage drop is 44.6mV. The subsequent calculations based on these measured data accurately verify the entire experimental process.

The experimental process clearly shows that when the motor is connected in parallel with a 1kΩ resistor, the motor cannot rotate because the applied voltage is insufficient to drive it. Subsequently, a buffered divider circuit is introduced for testing, and the test results fully demonstrate that the motor can rotate normally only when this buffered divider circuit is present. This result strongly emphasizes the significance of this circuit for the motor to function properly.

Further research involves the settings of the potentiometer, because different settings of the potentiometer will affect the rotation angle and speed of the motor. In the final stage of the research, a circuit design diagram for achieving clockwise and counter - clockwise rotation of the motor is presented. Overall, this experiment provides highly valuable reference information for deeply understanding the operating behavior of the motor under different voltage conditions, and also highlights the importance of buffer circuits for achieving the optimal operating performance of the motor.