

Triceratops Robot

Triceratops is one of the most well-known dinosaurs, belonging to the Ceratopsidae family. It is famous for its three horns and large frill. Typically, Triceratops has two long horns above its eyes and one short horn on its nose, with a large frill extending from the back of its head.

The muscle structure of Triceratops has been studied through the examination of its fossilized bones and comparisons with modern animals. Key aspects include

Neck Muscles: The neck muscles of Triceratops were likely very strong to support the large head and frill. These muscles would have helped in moving and positioning the head for feeding and possibly for combat or display.



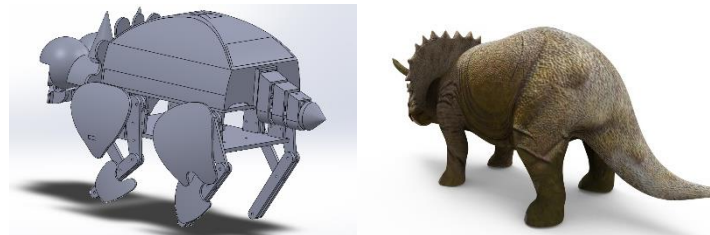
<https://www.turbosquid.com/3d-models/pentaceratops-horn-model-1630394>

Limb Muscles: The forelimbs and hindlimbs were robust, indicating strong musculature that could support the animal's massive weight. The muscles in the legs were likely arranged to provide stability and strength rather than speed.



<https://free3d.com/es/modelo-3d/triceratops-rigged-9506.html>

Back and Tail Muscles: The back muscles would have been strong to help support the large, heavy body. The tail muscles, while not as prominent, would have played a role in balance and possibly in communication or defensive behaviors.



<https://free3d.com/es/modelo-3d/triceratops-rigged-9506.html>

Physical and Biological Characteristics:

1. Muscle and Skeletal Structure:

- Triceratops is distinguished by its three horns, one on its nose and two above its eyes, which are supported by robust bones.
- Its muscles are particularly strong, especially around the neck and shoulders, to support the weight of its large head and horns.
- The hind leg muscles of Triceratops are robust to aid in walking and running over short distances.

2. Habitat and Behavior:

- Triceratops is a large herbivorous dinosaur that primarily feeds on plants, including ferns and palms.
- They inhabit forested areas and grasslands with abundant vegetation.

3. Locomotion and Movement:

- Triceratops walks on all fours, with longer hind legs than front legs, causing its body to slope forward.
- Its walking style is slow but steady, providing stability.

Using BIOinspire to create projects

The concept of Bioinspiration, or Bioinspire, involves drawing from nature to design and develop technology by studying and applying knowledge from living organisms. Examples include designing structures inspired by ant colonies or creating light traps based on the bioluminescence of certain insects.

In this project, the application of Bioinspire involves creating a robotic model of the Triceratops. This entails studying and incorporating knowledge about the Triceratops to design and develop a new robot that mimics various aspects of the dinosaur. For instance, the robot may have a body capable of movement, use tendons to replicate muscles, or have a sound production system. This approach acknowledges the intelligence of the Triceratops in adapting to its environment and interacting with it, using this as inspiration to create new technologies that can solve problems or provide benefits in various fields.

Potential applications include assisting in tasks within hazardous environments where human presence is risky, such as scanning and searching in dangerous or hard-to-reach places, or in research and studies about the behavior of Triceratops in nature to inform the design of future robotic movement and behavior. Applying Bioinspire in robotics can lead to the development of more efficient and useful technologies to solve everyday problems and opens opportunities for further study and experimentation to advance future technologies.

The mechanics of the robot inspired by the Triceratops can be summarized as follows:

1. 3D Printed Structure & Laser Cutting

- Designing the robot's structure to closely resemble or mimic the Triceratops' structure, such as joints that allow the robot to bend and move, or structural designs that enable coordinated movement.

2. Movement System:

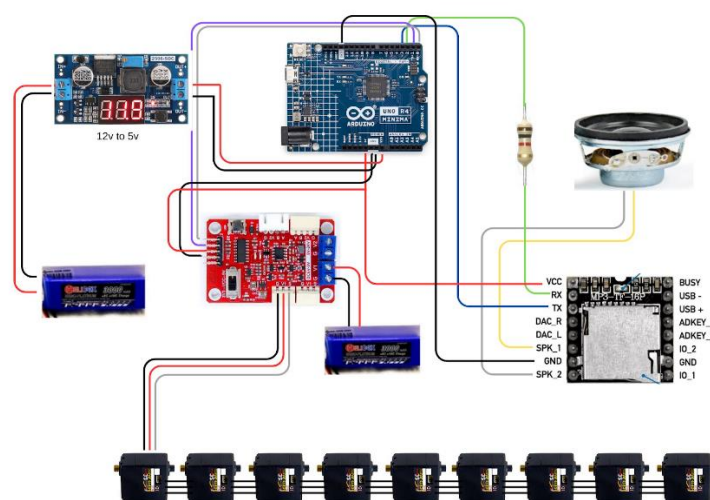
- Designing the robot's movement system to be flexible and efficient, emphasizing movement methods similar to the Triceratops. This includes using legs or joints as components for movement, driven by motors.

3. GUI Control

- Developing a control system that operates automatically and efficiently, allowing the robot to adapt and interact with its environment effectively, similar to how a Triceratops would.

Applying Bioinspiration to the mechanical aspects of the robot results in technology that is efficient and capable of operating effectively in various environments. This approach also ensures that the robot can perform tasks requiring high flexibility and efficiency.

Electronic equipment



All circuits use 5 volts of electricity

1.Servo Feetech SCS15



The Feetech SCS15 is a digital servo with metal gears and a wide range of motion. It is designed for use in robotic applications and can be controlled using a variety of methods, including UART, PWM, and analog.

SCServo can work at servo mode and wheel mode.

The servo mode can be used to multi-joints robot since the robots can be controlled with specific angles. (The factory default setting is servo mode)

The wheel mode can be used to wheel-type operation robots since motors of the robots spin infinitely. (If wheel mode is available you need to program the value of position limitation the both are 0.)

The range from 0 to 253 (0xFD) can be used (The factory default setting is ID 1), and, especially, 254(0xFE) is used as the Broadcast ID. If the Broadcast ID is used to transmit Instruction Packet, we can command to all SCServo
SCServo have kinds of baud rate available.

The baud rate from 38400 bps to 1M bps can be used. They are 38400, 57600, 76800, 115200, 128000, 250000, 500000, 1000000.
(The factory default setting is 1000000 bps)

SCServo can feedback the value of Position, Temperature, Load, Speed and Input Voltage. Also we can reprogram the speed of rotation, the max output torque, operating voltage limit, and operating temperature limit etc.

Features:

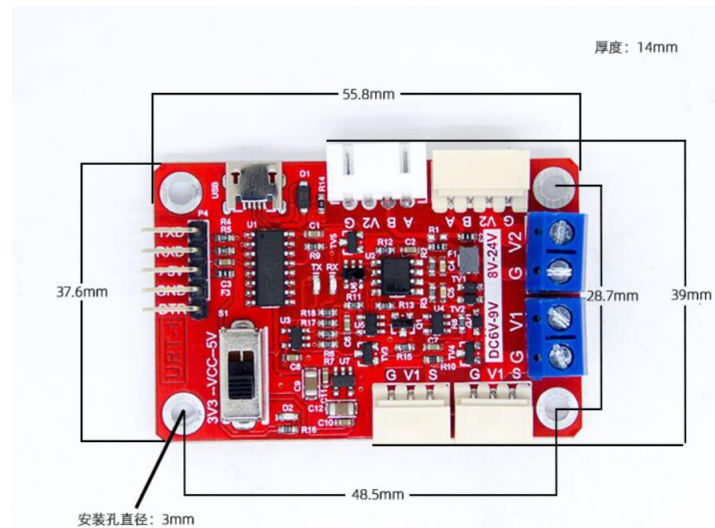
- Operating voltage: 6V to 8.4V
- Operating speed: 73 rpm at 8.4V
- Stall torque: 11.5 kg.cm at 7.4V
- Operating angle: 0° to 200°
- Gear ratio: 275:1
- Communication: UART, PWM, analog
- Dimensions: 40.0 x 20.0 x 40.5 mm
- Weight: 56 g

Additional information:

- The Feetech SCS15 servo is compatible with a variety of Arduino boards, including the Uno, Mega, and Leonardo.
- The servo can be controlled using the Servo library for Arduino.
- The servo can also be controlled using a variety of other programming languages, such as Python and C++.

Resources: <https://ecksteinimg.de/Datasheet/MO01016/SCS15.pdf>

2.FEURT-1



URT-1 multifunction serial signal converter, in order to facilitate the user to debug and use SMS and SCS composite Feite series serial servo design.

URT-1 integrated USB serial port chip, combined with linear low-voltage differential voltage regulator circuit, USB signal can be easily converted to 5V or 3V3 serial signal level.

In the URT-1 board, serial signal conversion circuit respectively into two different levels of signal, which A road - asynchronous half duplex RS485 level port can be connected to the SMS series servo; B - asynchronous half duplex TTL level single bus port can be connected to the SCS series of steering gear.

In the URT-1 board in the input and output signal by using asynchronous serial time-sharing using hardware circuit, hardware automatic diversion, without the use of additional IO enable to control, reduce the occupation of MCU port burden and code simple.

USB port using USB MINI interface; UART interface with 2.54 row spacing general; SMS series servo interface using 5264-4AW interface can be directly connected to the steering gear; SCS series servo interface using 5264-3AW interface can be directly connected to the steering gear.

The working voltage of SMS and SCS series servo fit is not the same, reuse requires a different working voltage, power supply port and can also access the SCS from the SMS section of the step-down power supply high voltage after making the system with a power supply to provide power.

Because the power port has overcurrent limit, the maximum is 6A, so it is necessary to do additional power distribution processing in the actual application of the serial connection of more servos. URT-1 is only used for signal conversion.

Features:

- Full speed USB device interface, compatible with USB V2.0
- Support baud rate 50 bps~1Mbps
- 5V and 3V3 UART serial port signal level can be switched freely
- Supports 32/64 bit Windows 10/8.1/8/7/VISTA/XP, SERVER 2016/2012/2008/2003/2000/ME/98
- Microsoft digital signature authentication
- SMS and SCS series servos can be shared by one serial port for control
- The serial port signal is asynchronous half duplex communication mode, and the hardware automatic diversion needs no additional enable IO
- The interface of servo system adopts error proofing connection to ensure proper connection

- UART interface is general pin way, can be used as USB to serial port output, also can connect MCU UART to control the steering gear
- With signal level power indicator (D1), TX (D2) and RX (D3) indicator, convenient to view data status
- The 5V voltage is supplied from the USB, otherwise the external voltage is supplied to the 5V
- 500mA overcurrent protection and overvoltage protection for USB power supply belt

Resources: <https://www.feetechrc.com/FE-URT1-C001.html>

3.speaker



AIYIMA 4Ω 3W speaker

The AIYIMA 4Ω 3W speaker is a small-sized speaker designed for use in mini stereo systems. Here are its features and specifications:

Features:

- Model: The speaker has a diameter of 40mm and a height of 20mm.
- Category: It is an electric speaker that operates based on the moving coil principle.
- Usage: Suitable for mini stereo speakers.
- Shape: The speaker is round.
- Components: It features a black side cover made of PU (Polyurethane).
- Diaphragm Material: The diaphragm is made of paper.
- Magnet Type: Uses a standard magnet type.
- Frequency Characteristics: This is a full-range speaker.
- Rated Power: 3 watts.
- Rated Impedance: 4 ohms.
- Frequency Response: Ranges from 0.20 to 20 kHz.
- Sensitivity: 83 dB/W.
- S/N Ratio (Signal to Noise Ratio): 83 +/- 3 dB.
- Harmonic Distortion: $\leq 5\%$ TMD (Total Harmonic Distortion).

This speaker is sensitive to sound signal changes and can respond to a wide range of frequencies, making it suitable for small or portable audio systems. However, with a harmonic distortion of $\leq 5\%$, some distortion may occur at the speaker's maximum volume.

Resources: <https://shorturl.asia/pIaM8>

4.DFPlayer Mini



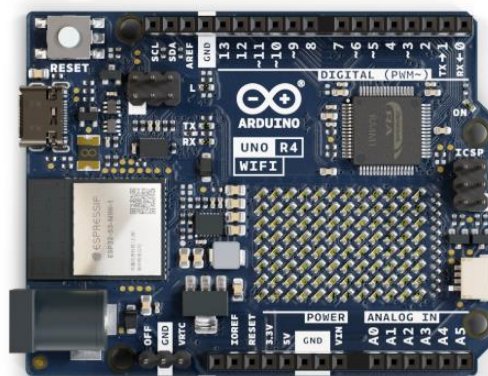
DFPlayer Mini module is a serial MP3 module provides the perfect integrated MP3, WMV hardware decoding. While the software supports TF card driver, supports FAT16, FAT32 file system. Through simple serial commands to specify music playing, as well as how to play music and other functions, without the cumbersome underlying operating, easy to use, stable and reliable are the most important features of this module.

Features:

- Support Mp3 and WMV decoding
- Support sampling rate of 8KHz,11.025KHz,12KHz,16KHz,22.05KHz,24KHz,32KHz,44.1KHz,48KHz
- 24-bit DAC output, dynamic range support 90dB, SNR supports 85dB
- Supports FAT16, FAT32 file system, maximum support 32GB TF card
- A variety of control modes, serial mode, AD key control mode
- The broadcast language spots feature, you can pause the background music being played
- Built-in 3W amplifier The audio data is sorted by folder; supports up to 100 folders, each folder can be assigned to 1000 songs
- 30 levels volume adjustable, 10 levels EQ adjustable.

Resources: <https://picaxe.com/docs/spe033.pdf>

5.Arduino R4



Description

The Arduino® UNO R4 WiFi is the first UNO board to feature a 32-bit microcontroller and an ESP32-S3 Wi-Fi® module (ESP32-S3-MINI-1-N8). It features a RA4M1 series microcontroller from Renesas (R7FA4M1AB3CFM#AA0), based on a 48 MHz Arm® Cortex®-M4 microprocessor. The UNO R4 WiFi's memory is larger than its predecessors, with 256 kB flash, 32 kB SRAM and 8 kB of EEPROM. The RA4M1's operating voltage is fixed at 5 V, whereas the ESP32-S3 module is 3.3 V. Communication between these two MCUs is performed via a logic-level translator (TXB0108DQSR).

Target areas:

Maker, beginner, education

Features

The **R7FA4M1AB3CFM#AA0**, often referred to as RA4M1 in this datasheet, is the main MCU on the UNO R4 WiFi, connected to all pin headers on the board as well as all communication buses

- **Overview**
 - 48 MHz Arm® Cortex®-M4 microprocessor with a floating point unit (FPU)
 - 5 V operating voltage
 - Real-time Clock (RTC)
 - Memory Protection Unit (MPU)
 - Digital-to-analog Converter (DAC)
- **Memory**
 - 256 kB Flash Memory
 - 32 kB SRAM
 - 8 kB Data Memory (EEPROM)
- **Peripherals**
 - Capacitive Touch Sensing Unit (CTSU)
 - USB 2.0 Full-Speed Module (USBFS)
 - 14-bit ADC
 - Up to 12-bit DAC
 - Operational Amplifier (OPAMP)
- **Power**
 - Operating voltage for RA4M1 is 5 V
 - Recommended input voltage (VIN) is 6-24 V
 - Barrel jack connected to VIN pin (6-24 V)
 - Power via USB-C® at 5 V
- **Communication**
 - 1x UART (pin D0, D1)
 - 1x SPI (pin D10-D13, ICSP header)
 - 1x I2C (pin A4, A5, SDA, SCL)
 - 1x CAN (pin D4, D5, external transceiver is required)

See the full datasheet for the R7FA4M1AB3CFM#AA0 in the link below:

- **R7FA4M1AB3CFM#AA0 datasheet**

The ESP32-S3-MINI-1-N8 is the secondary MCU with a built-in antenna for Wi-Fi® & Bluetooth® connectivity. This module operates on 3.3 V and communicates with the RA4M1 using a logic-level translator (TXB0108DQSR).

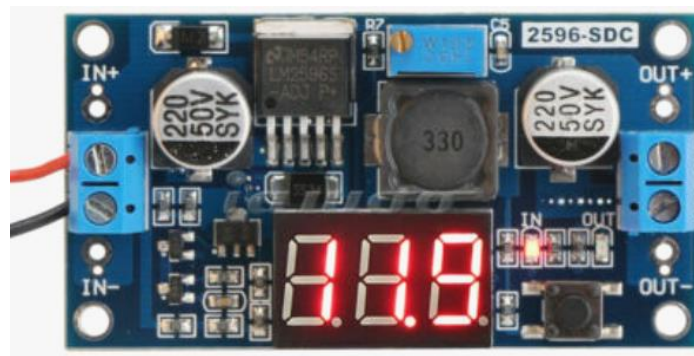
- **Overview**
 - Xtensa® dual-core 32-bit LX7 microprocessor
 - 3.3 V operating voltage
 - 40 MHz crystal oscillator
- **Wi-Fi**
 - Wi-Fi® support with 802.11 b/g/n standard (Wi-Fi® 4)
 - Bit rate at up to 150 Mbps
 - 2.4 GHz band
- **Bluetooth**
 - Bluetooth 5

See the full datasheet for the ESP32-S3-MINI-1-N8 in the link below:

- ESP32-S3-MINI-1-N8 datasheet

Resources: <https://docs.arduino.cc/resources/datasheets/ABX00087-datasheet.pdf>

6.Step Down



Features:

- with a display voltmeter , voltage meter error $\pm 0.1V$, range . 5 ~ 35V. (Note: The input voltage is below 4.5V, the onboard voltage meter does not work not shown)
- Large Volume 5 * 5 Touch key to switch the measurement input or output voltage , and indicator light display which is being measured terminal voltage . Digital display default initial input power voltage, and the input indicator IN lights; touch of a button, the output voltage of the digital display, and the output OUT indicator lights. And to keep the final set, then turn off even
- A voltmeter may be closed , press more switches 1 second and less than 4 seconds, can be let go off . After voltmeter switch closed as long as the press to open voltmeter.
- The input and output voltage measurement error calibrating function , press more switches 4 seconds after let go into the measurement errors of voltages than the standard function, this time IN lights (calibration input), the digital value representing flashing display (default parameters 0.0), then press the button can change the value

(value range -0.5 to 0.5, the unit is V), a positive number indicates an upward calibration, negative number indicates that the calibration downwardly. After adjusting the input calibrated value side, press more button for two seconds, let go into the error calibration output terminal, in which case OUT lights (calibrated output), and displaying the same calibration value output, adjustment method and the input terminal, the whole good after the calibrated value of the output terminal, press more button for two seconds, let go after saving the set values and return to normal display voltage correction value is set to take effect immediately and non-volatile. (With this feature, you can meet your higher precision)The terminal strip, no iron can be easy to use, and retain the wire bonding terminal points(Input voltage to be output must be higher than the above 1v)

- The output current up to the maximum . 3A , recommended operating current of about 2A, 2A exceeds plus fins
- The use of the internal oscillation frequency of 400KHz, a second-generation switching voltage regulator, low power consumption, high efficiency

Instructions:

- The input and output voltages than the standard error of measurement: Press more switches 4 seconds after let go into the measurement errors of voltages than the standard function, this time IN lights (calibration input), the digital value representing flashing display (factory parameters 0.0), then press the button can change the value (value range -0.5 to 0.5, the unit is V), a positive number indicates an upward calibration, negative number indicates that the calibration downwardly. After adjusting the input calibrated value side, press more button for two seconds, let go into the error calibration output terminal, in which case OUT lights (calibrated output), and displaying the same calibration value output, adjustment method and the input terminal, the whole good after the calibrated value of the output terminal, press more button for two seconds, let go after saving the set values and return to normal display voltage correction value is set to take effect immediately and non-volatile. (With this feature, you can meet your higher precision)
- Close voltmeter : Press switch for more than one second and less than four seconds, can let go off . After voltmeter switch closed as long as the press to open voltmeter.

Precautions:

- recommended power usage exceeds 20W , the need to add heat sinks to enhance cooling ;
- a customer module to reflect the output voltage can not be adjusted , it is always equal to the input voltage. When you encounter this problem, please counterclockwise rotary potentiometer more than 10 laps, and then use module can properly adjust the voltage.

Applications:

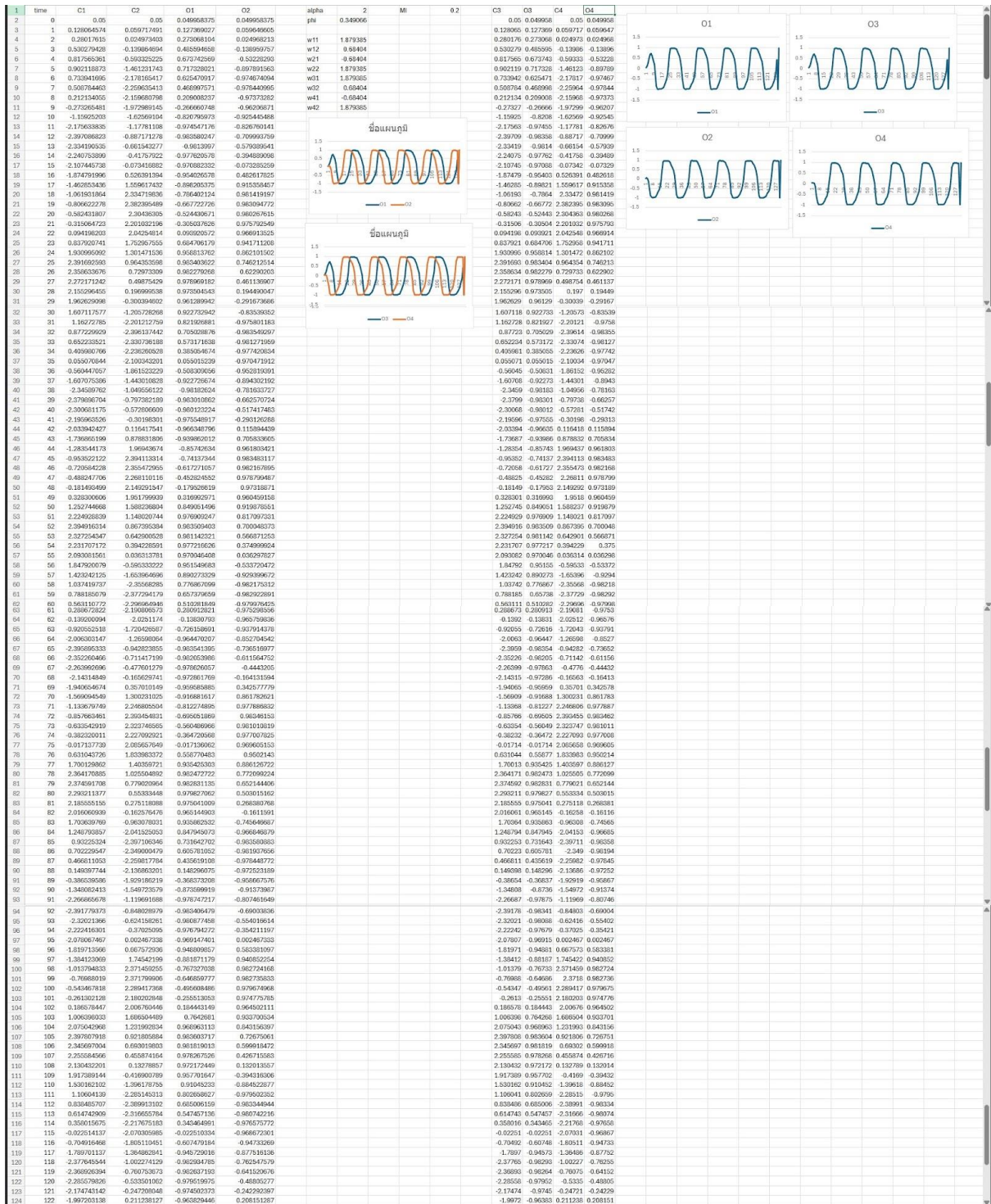
This module can be used in the field of boosted output voltage higher than the input voltage of the input, such as a battery, power transformers, DIY adjustable power supply, 24V car T of the power supply, industrial equipment buck, 9 turn 12 is V , 12v Turn 18 V , 18 is V switch 24 V and the like.

Resources: <http://www.weenatech.com/product/41/xl6009-boost-step-up-module-power-supply-led-voltmeter>

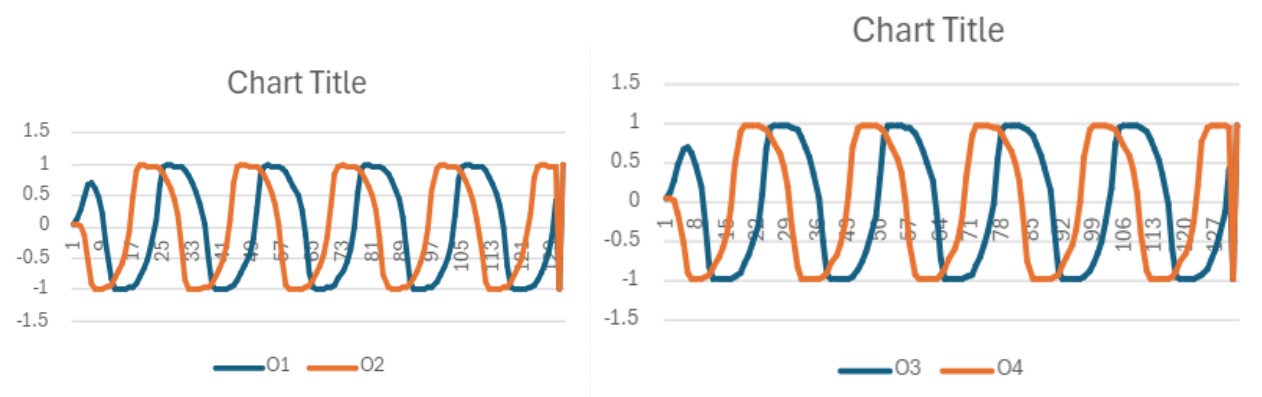
Technical

1.CPGs

Central pattern generators (CPGs) are neural circuits located within the spinal cord that are responsible for generating rhythmic motor outputs without continuous input from the brain. They act like a conductor in an orchestra, coordinating the firing of muscles to produce smooth, automatic movements like walking, swimming, breathing, and chewing.



125	123	-1.66902297	1.050494027	-0.931422392	0.781998584	-1.66902	-0.93142	1.050495	0.781999
126	124	-1.215862962	2.106807038	-0.83846392	0.970849658	-1.21586	-0.8385	2.106807	0.970849
127	125	-0.911476296	2.368955794	-0.721941033	0.963611773	-0.91148	-0.72194	2.368956	0.963612
128	126	-0.653767305	2.342353796	-0.550976025	0.961696156	-0.65379	-0.55098	2.342354	0.961696
129	127	-0.444768688	2.251292557	-0.4176059	0.978082225	-0.44479	-0.41761	2.251293	0.978082
130	128	-0.11579472	2.123852558	-0.11527994	0.971809034	-0.11579	-0.11528	2.123853	0.971809
131	129	0.448191113	1.963259679	0.420336968	0.956655481	0.448191	0.420337	1.96326	0.956655
132				-0.983580247	-0.983580983				
133				0.983603717	0.983611773				
134									



CPG controls alternating leg movements. Step speed and balance.

Equation for calculation

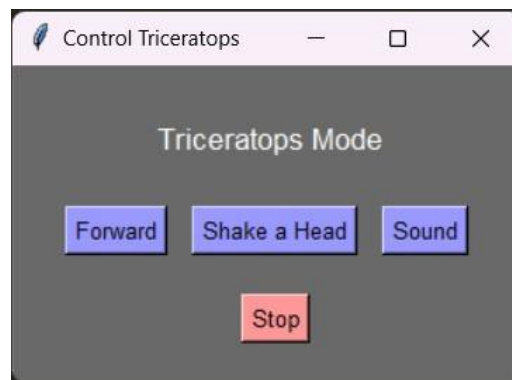
$\alpha = 1.08;$

$\phi = M_PI/9.0;$

$W11 = \alpha \cdot \cos(\phi), W12 = \alpha \cdot \sin(\phi), W21 = -\alpha \cdot \sin(\phi), W22 = \alpha \cdot \cos(\phi), W31 = \alpha \cdot \cos(\phi), W32 = \alpha \cdot \sin(\phi), W41 = -\alpha \cdot \sin(\phi), W42 = \alpha \cdot \cos(\phi);$

2.MQTT

MQTT (Message Queue Telemetry Transport) is a lightweight publish/subscribe messaging protocol designed for resource-constrained devices and low-bandwidth networks. It is commonly used in Internet of Things (IoT) applications to connect sensors, actuators, and other devices to cloud services or other applications.



Use the MQTT function to receive commands from the GUI and send them to the Arduino R4 board so that the robot can work as specified.

- Forward: Commands for ordering the robot to move forward.
- Shake a Head: Commands for making the robot shake its head left to right.
- Sound: Command the robot to make a sound.
- Stop: Command the robot to stop operating in all modes. and return to the set position.

Refer

- TurboSquid. (2024, May 22). Pentaceratops Horn 3D Model. Retrieved from <https://www.turbosquid.com/3d-models/pentaceratops-horn-model-1630394>
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