

super BOT GEARS



INSTRUCTIONS

WARNING!

 To power up the set use only a reliable 5V 450mA DC power supply unit or an old phone charger.

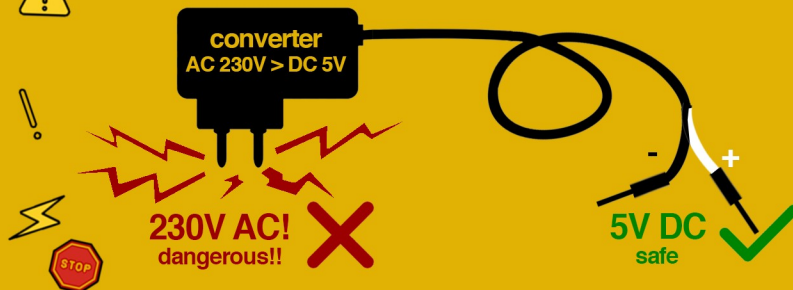
NEVER plug any cables directly to the AC power socket!!

The current in the socket has a very high voltage (230V) and is very dangerous!!

Your 5V power supply unit converts the dangerous 230V AC current into safe 5V DC* current.

The electronic circuits described in this manual use only the 5V DC current, which is safe to work with. You can even touch the 5V cables.

(the 5V DC current is safe for people, but can still be harmful for the electronics if the wires are not connected correctly! Be careful!)



*AC means Alternating Current

DC means Direct Current

Direct current always move in one direction from plus to minus

Alternating Current changes the direction in which it moves

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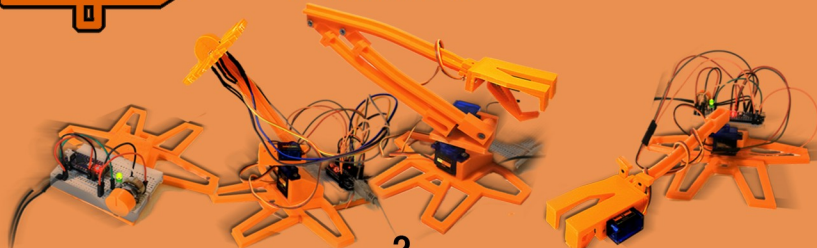
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7.1. What next?



How does electricity work?

Electric current - flow of electric charges (usually electrons).

The current can flow easily through CONDUCTORS (i.e. copper, gold, steel, silver, graphite), but struggles to flow through isolators (i.e. rubber, vinyl, glass, air). The voltage of the electric current is measured with VOLTS (V), current in AMPS (A), and resistance in OHMS (Ω).

Where can you find electric current?:



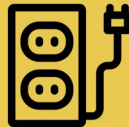
AA battery

voltage: 1.5V
(safe, low voltage)



lightning strike

voltage: around 1 000 000 000V
(huge voltage and huge energy carried in a very short time)



AC socket

voltage: 230V
(dangerous, high voltage)



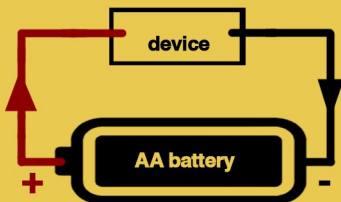
static spark

voltage: around 750-2 500V
(very high voltage, but the energy is very small and the time of a spark is very short, so it doesn't cause real harm)

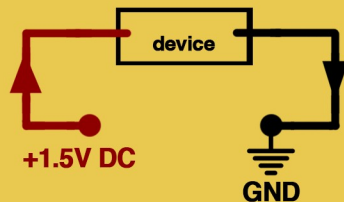
In our set we will be using 5V DIRECT CURRENT. The direct current always flows in one direction: from PLUS to MINUS

In electronic circuits the PLUS is usually mared with **red**, and MINUS with **black** (there are some exceptions sometimes).

These diagrams depict similar circuits:



Simple electronic circuit:
the battery powers the device



In DC current the minus is sometimes called the **GROUND** and is marked with the symbol \equiv or GND



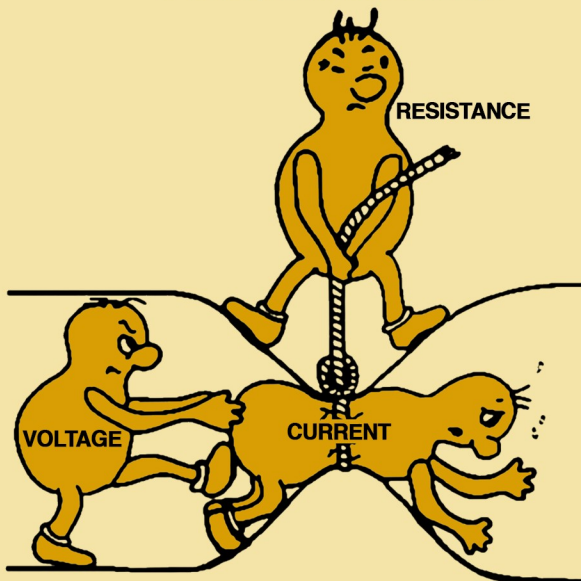
It's not needed for the purpose of our set, but the electric current is described with these three properties (and their units):

VOLTAGE “U” (V volt) - the difference in electric potential between two points in the circuitry.

CURRENT “I” (A ampere) - rate of flow of electric charge past a certain point or region in the circuit.

RESISTANCE “R” (Ω ohm) - measure of the opposition to the flow of electric current

It sounds quite complicated, but we can sum it up with this drawing:



Or with these equations:

$$I = \frac{U}{R} \quad \left(A = \frac{V}{\Omega} \right) \quad (\text{it's Ohm's law!})$$



What is Arduino?

Arduino - prototyping programming platform distributed in the “open source”* model, designed for teaching of programming, electronics, robotics. Arduino is very popular among students, amateur designers and artists.

In the common meaning “Arduino” is an electronic board with a small micro-computer capable of executing simple computer programs.

Arduino can read the states of SESORS (electronic equivalent of senses) and process the collected information according to the program. Arduino can control lighting, motors or even be the brain of simple robots!

Every one of 5 variants included in the “Super Bot Gears” set has a separate PROGRAM, which needs to be installed on the Arduino Nano board before you assemble the mechanical parts.

***Open source** is a model of distributing the intellectual property (software, products, art pieces...) in which the author releases the work **for free** and lets others use and edit it.

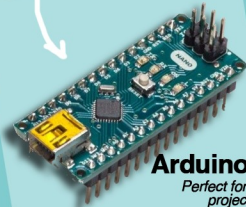
WORTH KNOWING

The “Super Bot Gears” set is also an open source project, so everyone can download it from the internet for free!

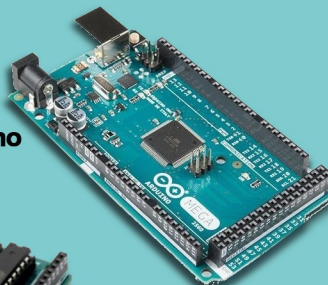
this board is used
in the set!

mechanics
+
electronics = MECHATRONICS

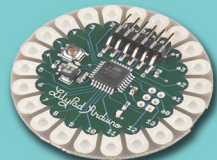
Examples of Arduino boards:



Arduino Nano
Perfect for small projects!



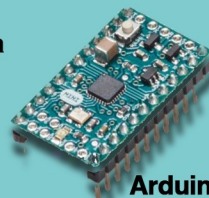
Arduino Mega
For big and complex projects



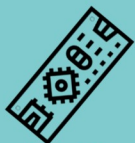
Arduino Lilypad
For electronical and interactive... clothes! You can sew it onto fabrics!



Arduino Uno
For beginners



Arduino Mini
For very small projects



Installation

Download the Arduino IDE software and a driver

Install the Arduino IDE programming environment and the "CH340" driver (if you are not using a genuine Arduino board)



After you installed ARDUINO IDE and the driver, open the program and go to "Tools>Board" and chose "Arduino Nano"

CONGRATULATIONS! :D

You can now upload the programs to your Arduino Nano board! the set includes following programs:

"BlinkSBG"

"FadeSBG"

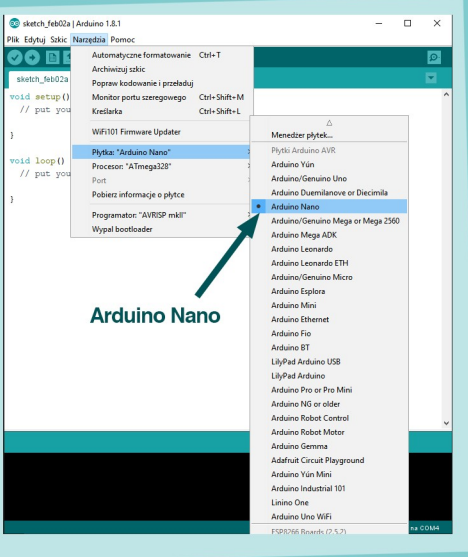
"DragonSBG"

"FlowerSBG"

"RoboarmSBG"



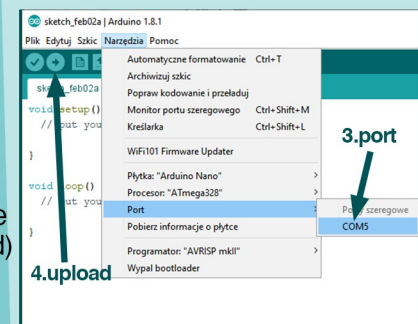
If you have any problems with the setup, ask an adult for help!



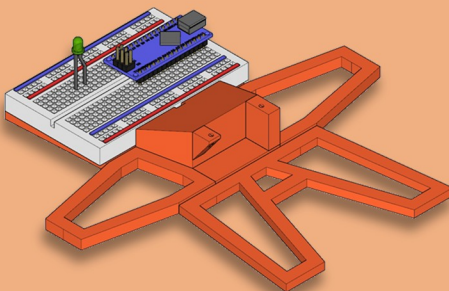
The program should be uploaded **before you assemble the mechanical parts** of the chosen variant. If you don't plan to use the board for a longer time, it is recommended to upload the "BlinkSBG" program, so that the board doesn't start to run some old and forgotten program when you power it up the next time.

TO UPLOAD THE PROGRAM TO THE ARDUINO BOARD:

1. Plug the board to your computer with an USB cable
2. Open the chosen program
3. Go to Tools > Port and choose the available port (usually it's called COM)
4. Click the UPLOAD button
5. Wait until the program is uploaded (the board should be blinking during the upload)
6. Disconnect the Arduino from your computer

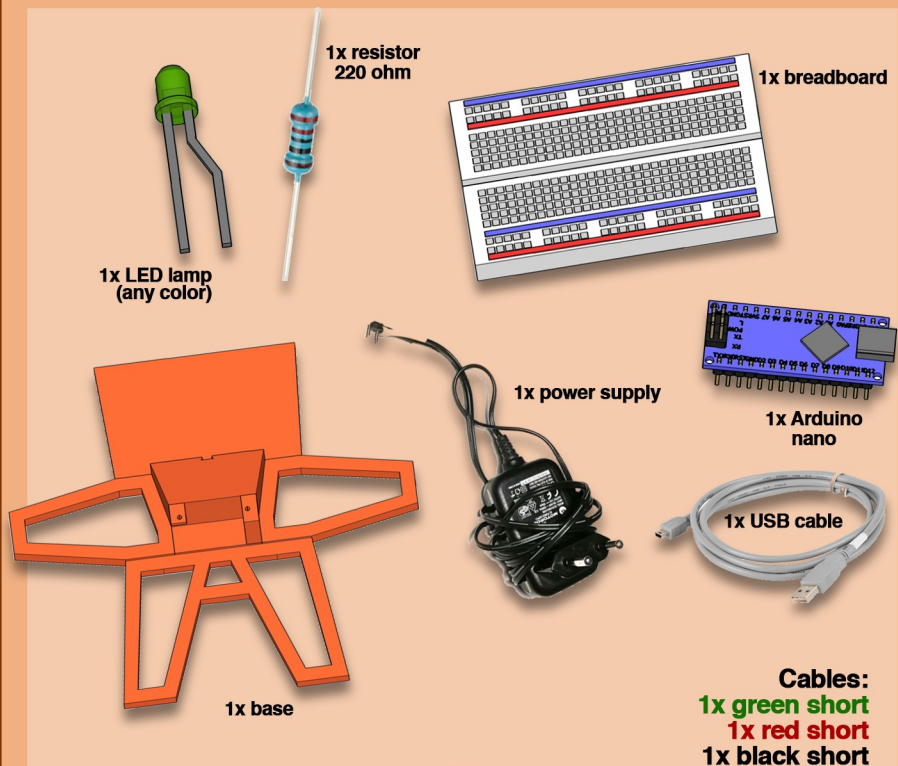


BLINK

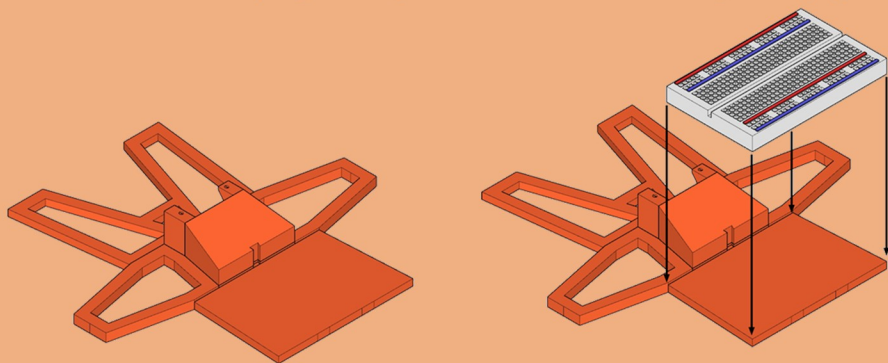


Every Arduino adventure starts with the BLINK program!
It's the simplest example of using of the Arduino board. In the blink example Arduino nano is controlling the LED (Light Emitting Diode)

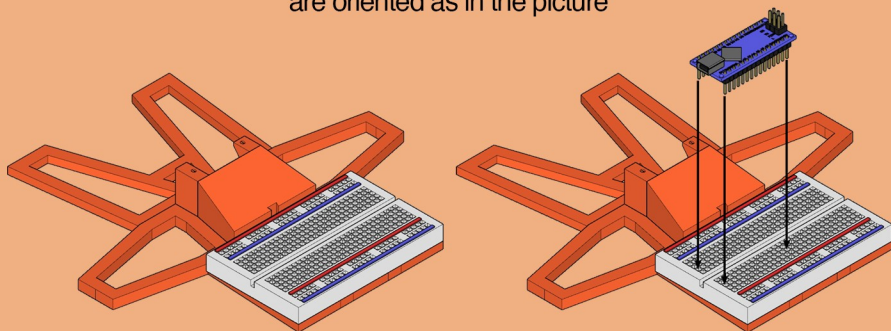
PREPARE:



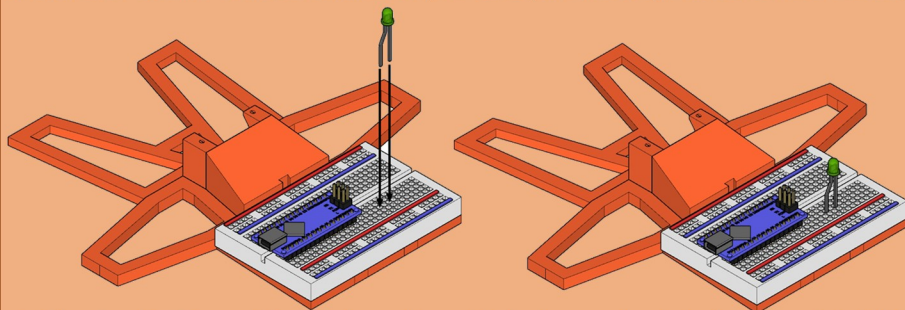
1. Install the BlinkSBG program on your Arduino board according to the page 6



2. Attach the breadboard to the base in a way, so that the red and blue stripes are oriented as in the picture



3. Carefully, so that you don't break the Arduino pins and don't cut your fingers, attach the Arduino to the breadboard (the D13 pin should go into the H30 socket)



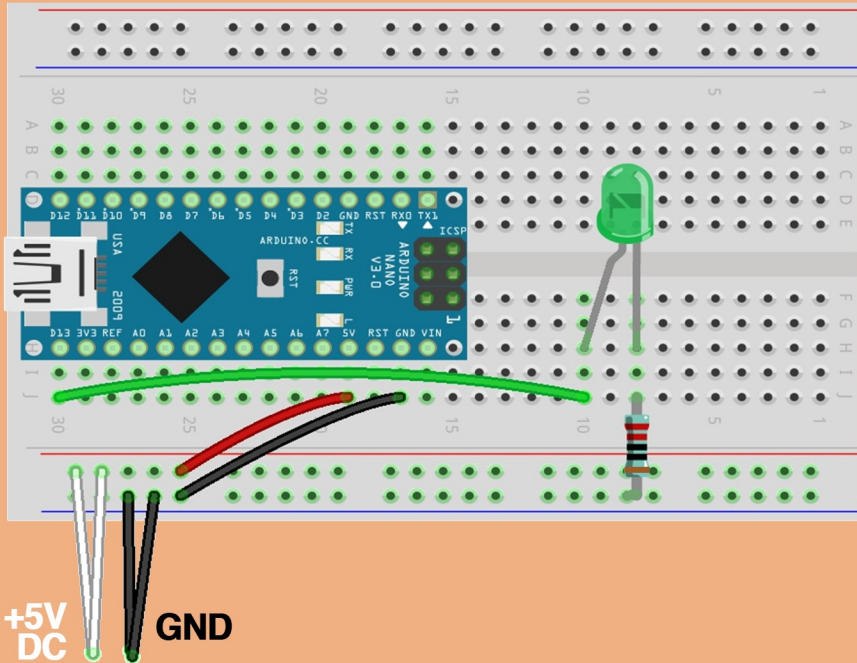
4. Plug the LED lamp into the breadboard. The longer leg (+) should go into H10 and the shorter leg (-) into the H8

The longer leg of an LED is always a (+), the shorter one is a (-). In case of an LED lamp the polarity (orientation) matters, since an LED only lets current through in one direction!

**EXTRA KNOWLEDGE
FOR THE CURIOUS**



Electronics:



5. Plug the green cable into J30 and J10. Plug the red cable into the POSITIVE BUS (marked with red strip and a plus) and J19 (5V). Plug the black cable into the NEGATIVE BUS (marked with blue strip and a minus) and J17 (GND)

Plug the resistor into the negative bus and J8. The polarity (orientation) of the resistor doesn't matter

Plug the power supply into the breadboard as it's depicted in the diagram. The +5V cable should be plugged into the positive bus, the ground cable should be connected into the negative bus.

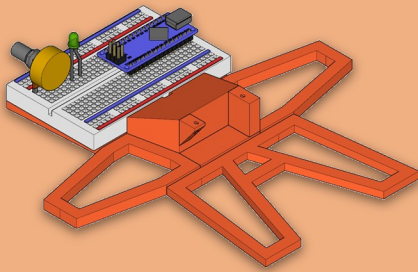
Double check all the connections and plug the power supply into the AC socket!

Does it work?? :)



EXTRA KNOWLEDGE FOR THE CURIOUS

The resistor "opposes" to the flow of electric current in the circuit. The higher the resistance, the smaller the current. In the Blink circuit, the resistor limits the current flowing through the LED lamp. Without the resistor, the LED would let too much current through and it would momentarily burn up!. The strips drawn on the case of the resistor code the value of its resistance. The value can be decoded with the resistance table. In this case the strips mean: "2", "2", "0", "times 1", " $\pm 1\%$ " so "220 ohm with a tolerance of $\pm 1\%$ "



extro FADE



Let's modify the **Blink example** so that we can control the brightness of the lamp! Let's do it with a **POTENTIOMETER**. A potentiometer is a knob, which changes its resistance depending on the setting. Potentiometers can often be found in speakers and audio amplifiers.

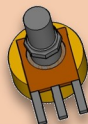
PREPARE:



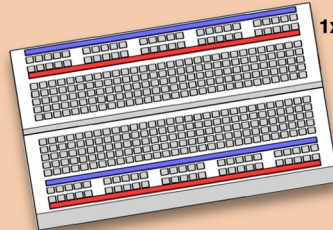
1x LED lamp
(any color)



1x resistor
220 ohm



1x potentiometer
10kOhm



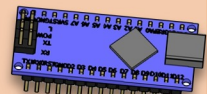
1x breadboard



1x base



1x power supply



1x Arduino
nano



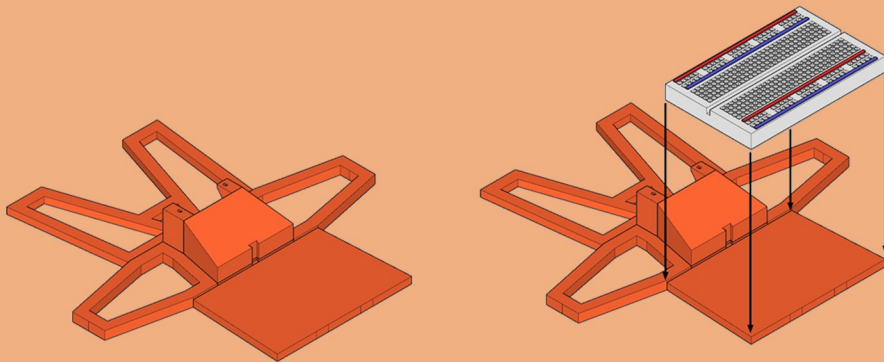
1x USB cable



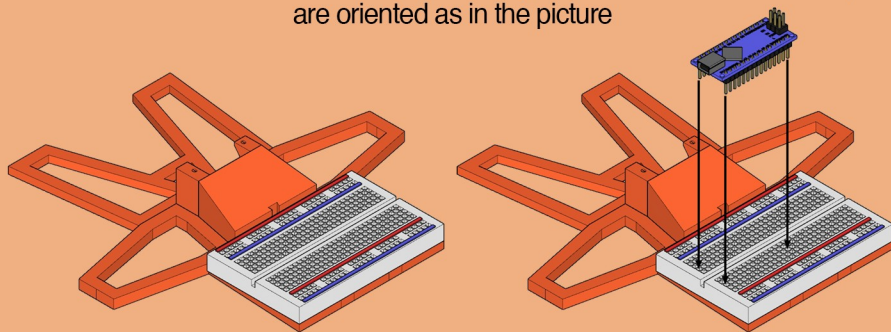
1x knob

Cables:
 1x green short
 2x red short
 2x black short
 1x white short

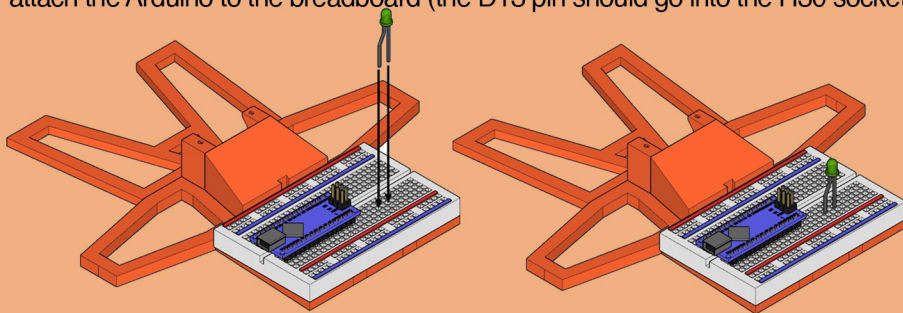
1. Install the BlinkSBG program on your Arduino board according to the page 6



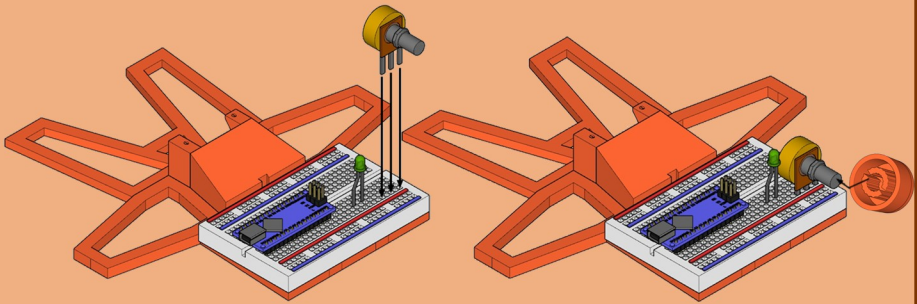
2. Attach the breadboard to the base in a way, so that the red and blue stripes are oriented as in the picture



3. Carefully, so that you don't break the Arduino pins and don't cut your fingers, attach the Arduino to the breadboard (the D13 pin should go into the H30 socket)

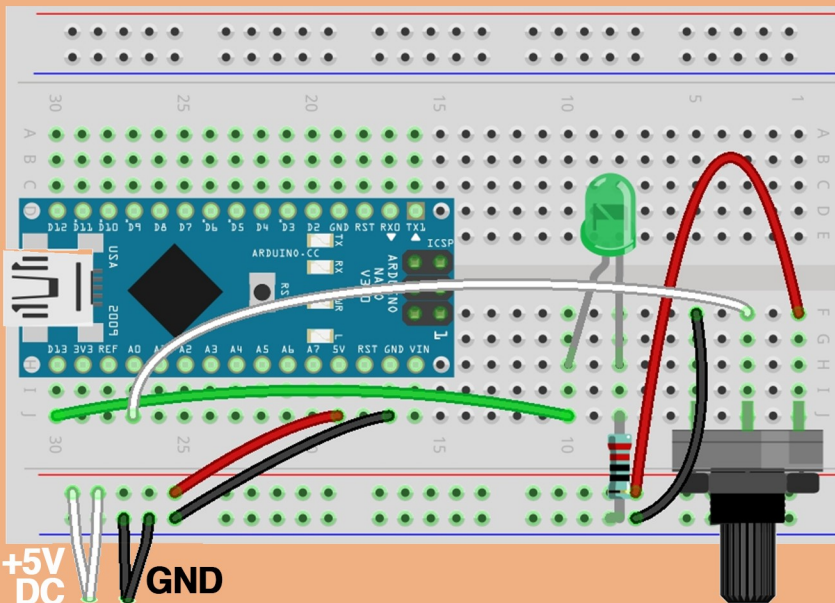


4. Plug the LED lamp into the breadboard. The longer leg (+) should go into H10 and the shorter leg (-) into the H8



5. Plug the potentiometer into the breadboard so the the pins go into the J1, J3 and J5 sockets. You can also attach the 3D printed knob!

Electronics:



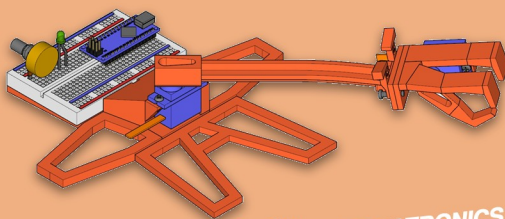
6. Plug the green cable to J30 (D13) and J10. Plug the red cable to J19 (5v) and positive bus. Plug the black cable to J17 (GND) and negative bus. Plug the white cable to J27 (A0) and F3. Plug the 2nd red cable to F1 and positive bus. Plug the 2nd black cable to F5 and negative bus. Plug the resistor to J8 and the negative bus (the polarity doesn't matter)

Plug the power supply to the power buses (+5V to the positive, GND to the neg.)

Double check all the connections and plug the power supply into the AC socket!

You can now fade the lamp with a potentiometer!!

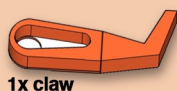
wild DRAGON



mechanics
+ electronics = MECHATRONICS

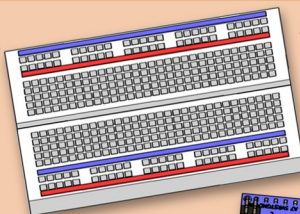
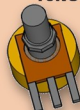
The previous examples were strictly electronic. The wild dragon can move, which make it a MECHATRONIC project. With the potentiometer you can now moderate how angry the dragon is!!

PREPARE:



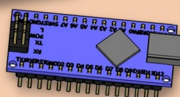
1x claw

1x potentiometer
10kOhm

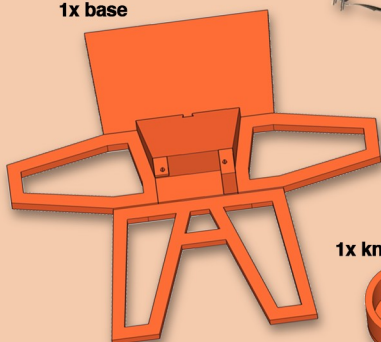


1x breadboard

1x Arduino
nano



1x base



1x power supply



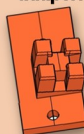
1x kabel USB



1x knob



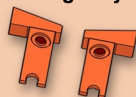
1x gripper
adapter



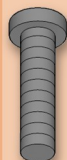
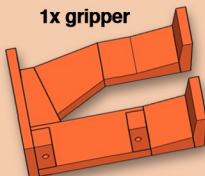
2x servo
motors



2x dragon eyes



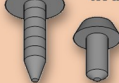
1x gripper



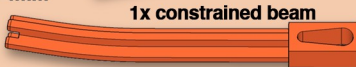
2x bolt 12mm M3

2x bolt 8mm

4x bolt 4mm



1x constrained beam



Cables:

2x red short

2x black short

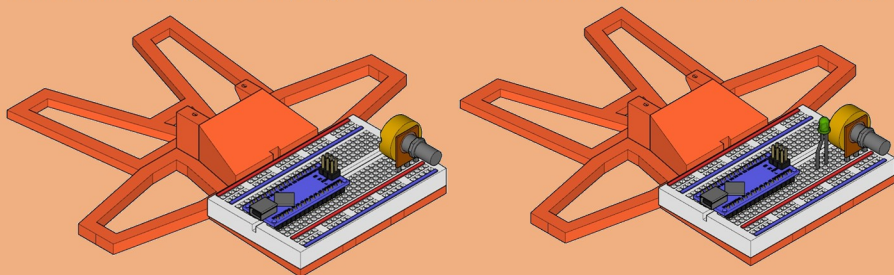
1x white short

2x orange long

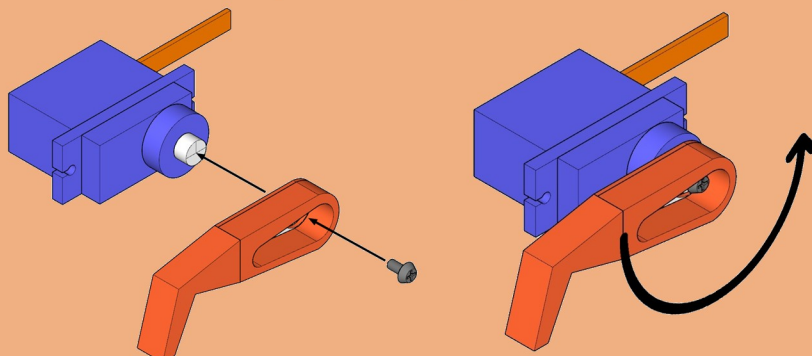
2x red long

2x brown long

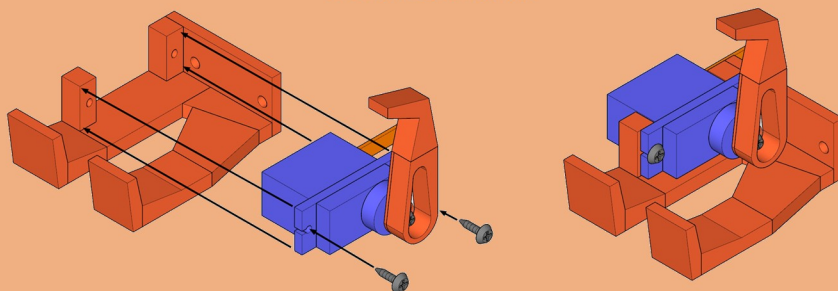
1. Install the DragonSBG program on your Arduino board according to the page 6



2. You can use your Fade example or start from scratch



3. Attach the claw to your SERVO MOTOR so that it can make half of a rotation according to the black arrow. Attach the claw with a 4mm bolt and a small screwdriver

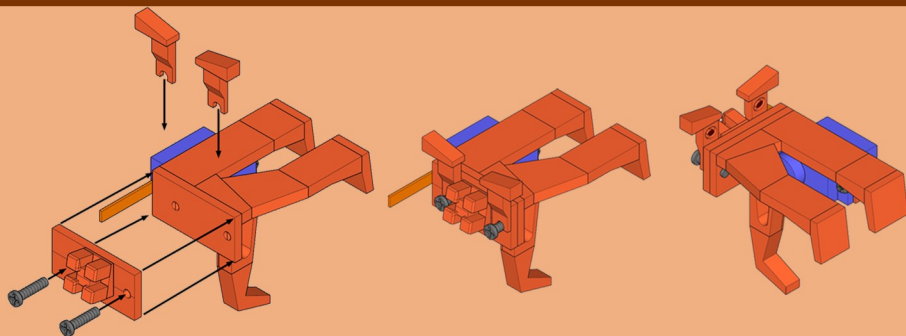


4. Attach the servo to the gripper with 8mm bolts using a screwdriver

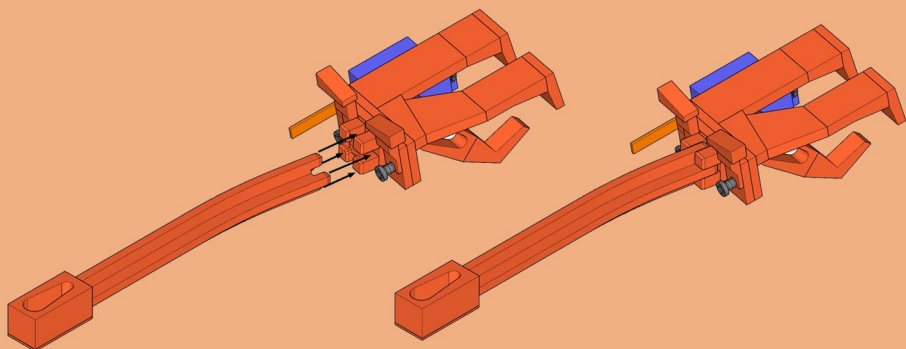
A SERVO MOTOR is a special motor that can precisely hold a certain set position. Thanks to a sensor hidden inside of the motor, servo "knows" what direction it is pointing at and it will change the position in order to match the position set by the program. Servo motors can be found in real robots!

**EXTRA KNOWLEDGE
FOR THE CURIOUS**

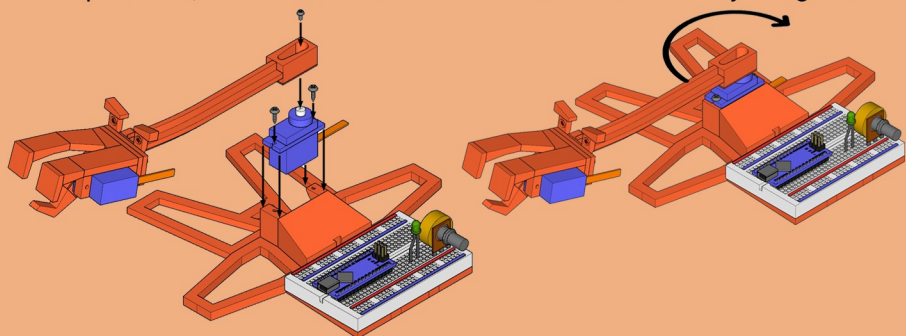




5. Attach the gripper adapter to the gripper with 12mm M3 bolts. Don't screw the bolts all the way in - leave a few mm so that you can attach the eyes of the dragon



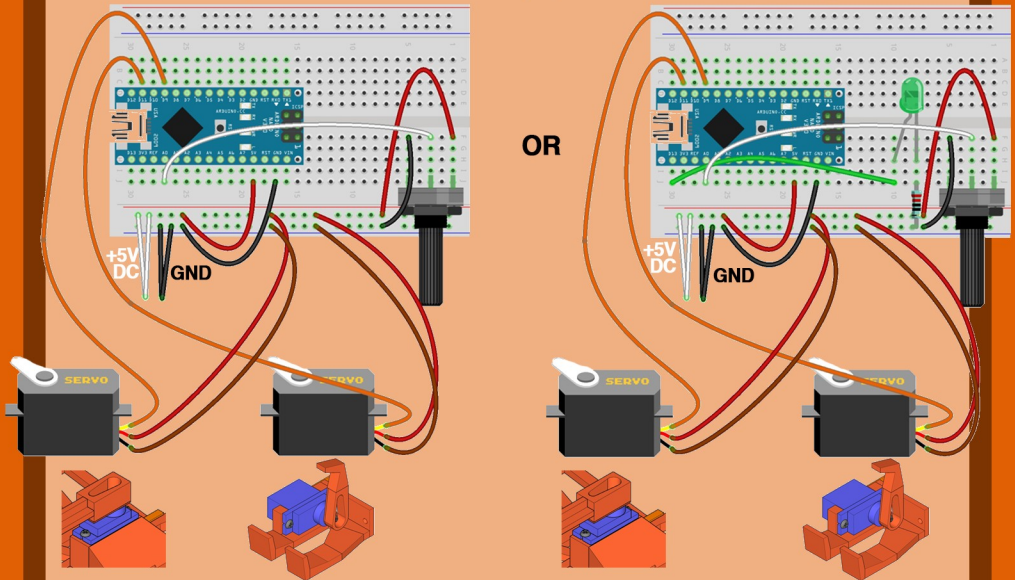
6. Carefully, not to break the elements, attach the adapter to the beam. If you have problems, ask an adult to sand the connectors so that they fit together.



7. Attach the 2nd motor to the base with 8mm bolts. Attach the neck of the dragon to the servo motor with 4mm bolt, so that it can make half of a rotation according to the black arrow.

Electronics

If you started this assembly from scratch, your circuit should look like the left diagram. If you used the Fade example, it should look like the right one



8. Plug the short red wire into J19 and the positive bus. Plug the short black cable into J17 and the negative bus. Plug the 2nd short cable to F1 and the pos. bus. Plug the 2nd short cable into F5 and the negative bus. Plug the white cable to F3 and J27 (A0).

Connect the BASE MOTOR with a red long cable to the positive bus, with a brown long cable to the negative bus and with the orange long cable to C27 (D9)

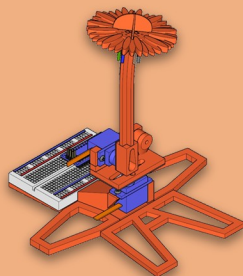
Connect the GRIPPER MOTOR with a red long cable to the positive bus, with a brown long cable to the negative bus and with the orange long cable to C29 (D11)

Connect the power supply to the positive and negative bus

Double check all the connections and plug the power supply into the AC socket!

When you power up the dragon it will immediately start to move around and try to bite angrily! You can calm it down with a potentiometer!

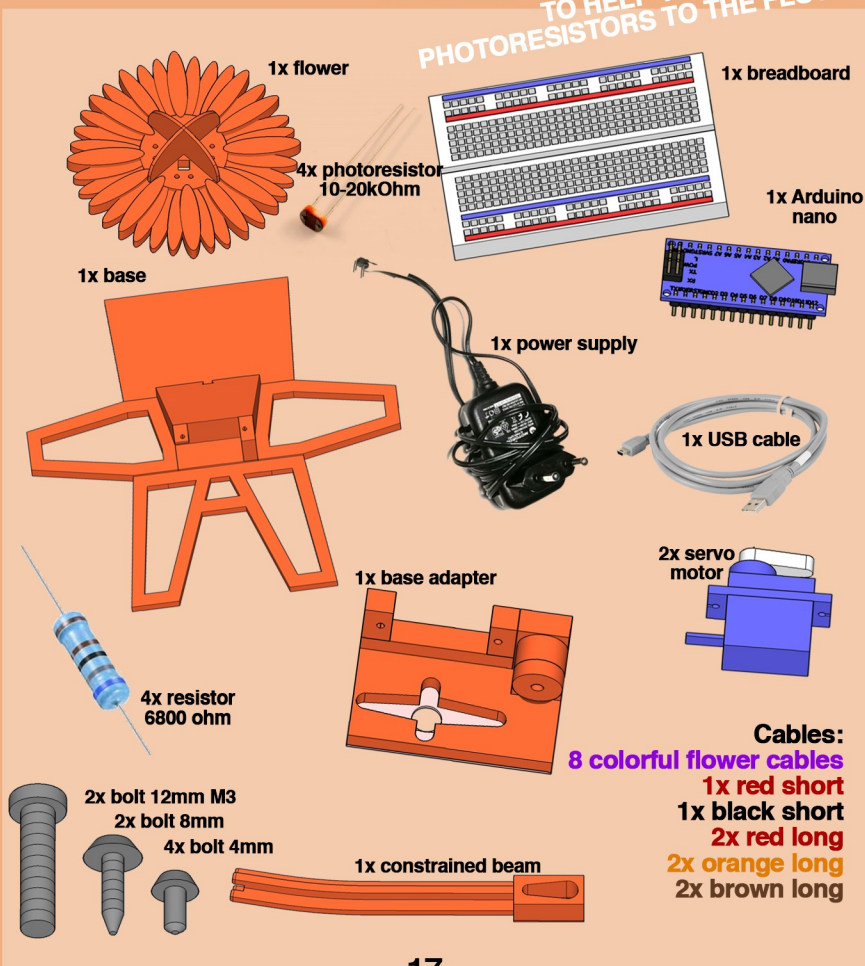
POWER FLOWER



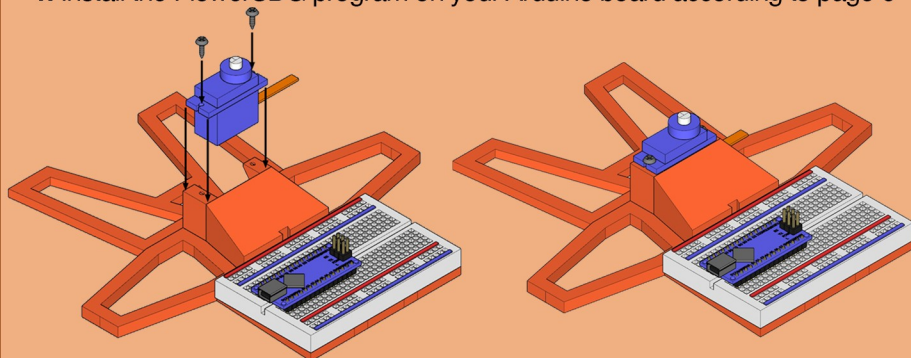
Many flowers can autonomously follow the sun. Can we build a robot that would do the same? Let's try!

PREPARE:

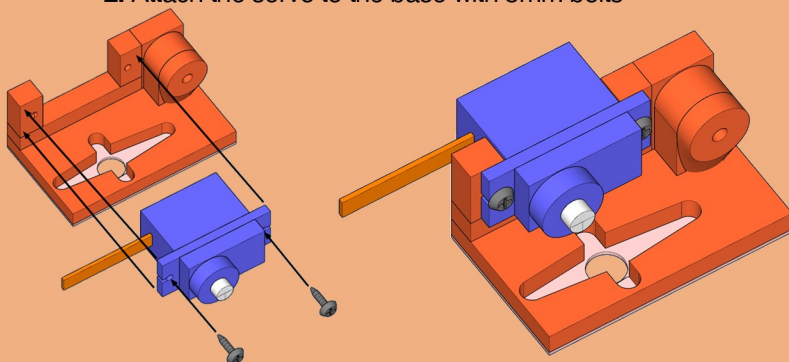
ASK AN ADULT TO HELP YOU ATTACH THE PHOTORESISTORS TO THE FLOWER!



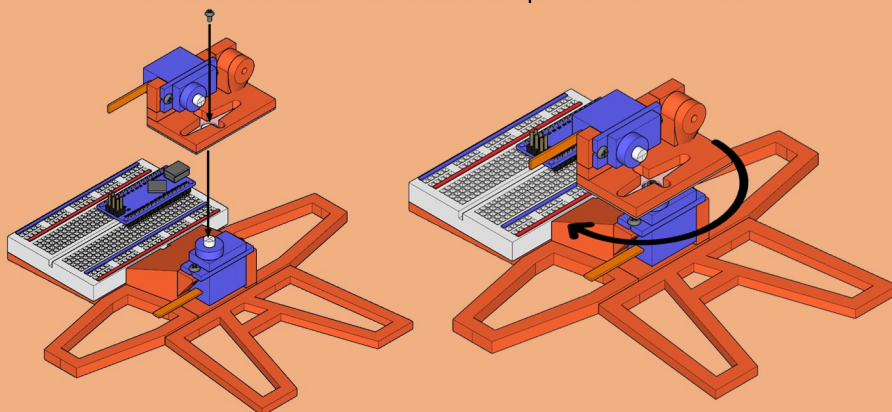
1. Install the FlowerSBG program on your Arduino board according to page 6



2. Attach the servo to the base with 8mm bolts

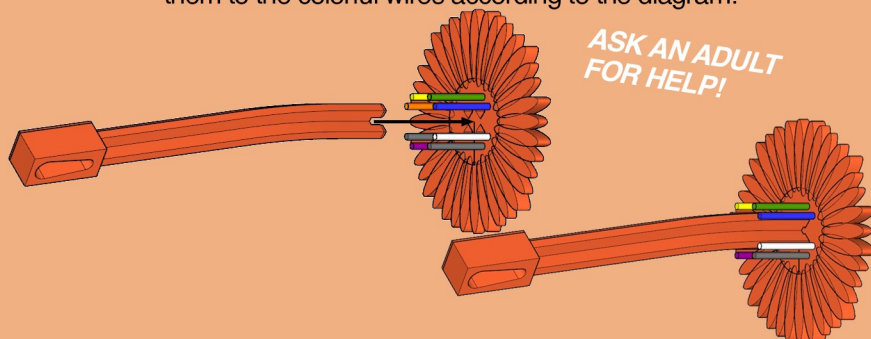


3. Attach the servo to the base adapter with 8mm bolts

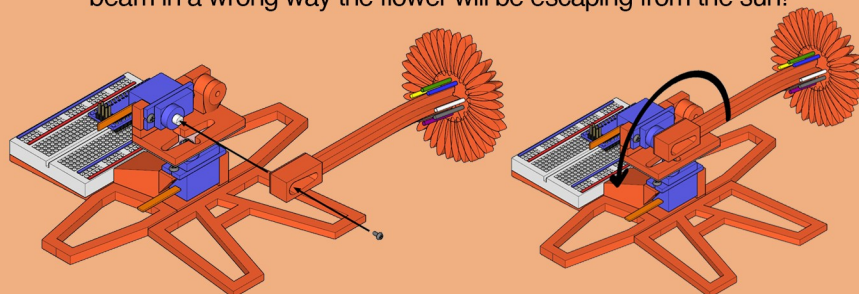


4. Attach the base adapter to the base servo with a m4 bolt in a way, so that it can make half of a rotation according to the black arrow

- 4.5. Ask an adult to help you attach the photoresistors to the flower and solder them to the colorful wires according to the diagram:



5. Carefully, not to damage the parts and cables, attach the beam to the flower. **NOTE THE ORIENTATION OF THE COLORS!** If you attach the beam in a wrong way the flower will be escaping from the sun!



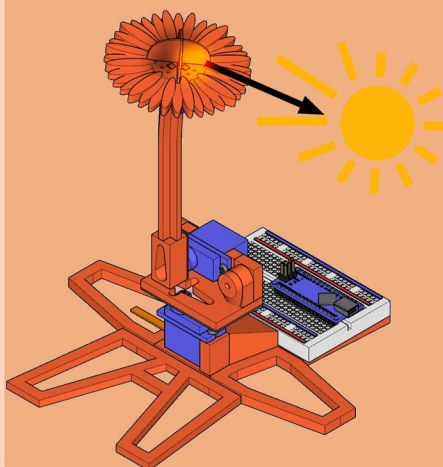
6. Attach the flower stem to the base adapter servo in a way, so that it can make half of a rotation according to the black arrow. Use a 4mm bolt.



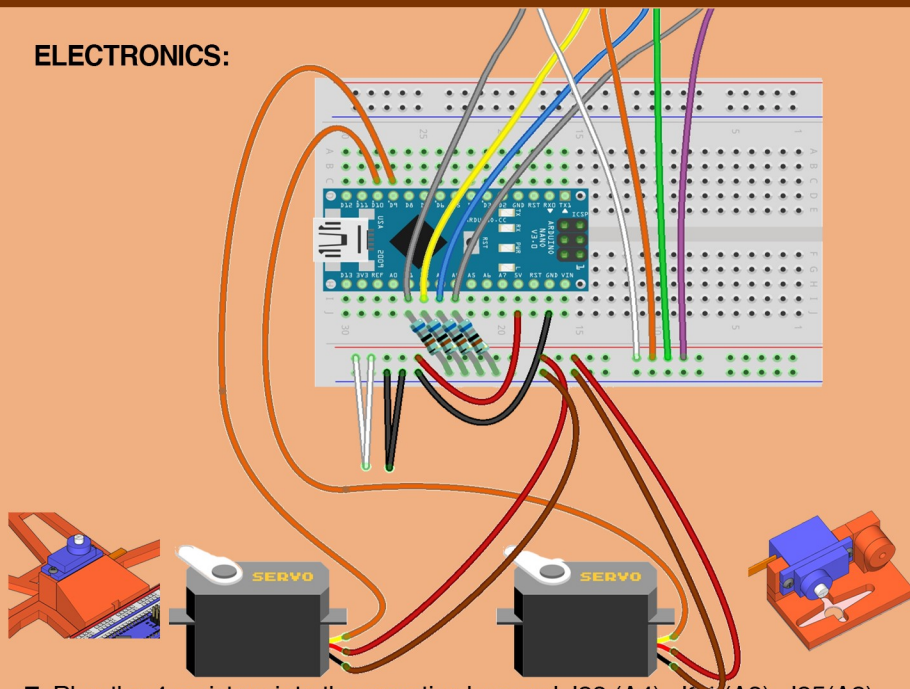
EXTRA KNOWLEDGE FOR THE CURIOUS

The flower will be able to follow the light thanks to the **PHOTORESISTORS** (the four components attached to the top of the flower). The photoresistors are resistors that change the value of the resistance depending on the illumination levels.

Thanks to the cross-shaped shades, each photoresistor is lit with a different intensity. The flower will tilt in the direction of the photoresistor, that is lit the most. This way it can follow a strong light source!



ELECTRONICS:



7. Plug the 4 resistors into the negative bus and J23 (A4), J24 (A3), J25(A2), and J26 (A1). The white, orange, green and purple cables coming out of the flower should be plugged into the positive bus. The 1st grey cable (attached to the white one) should be plugged to J26 (A1), the yellow to J25 (A2), blue to J24 (A3) and the 2nd grey one (attached to the purple one) to J23 (A4)

Plug the red short wire to J19 (5v) and the negative bus. Plug the short black wire to J17 (GND) and the negative bus.

Connect the BASE MOTOR with a red long cable to the positive bus, with a brown long cable to the negative bus and with the orange long cable to C27 (D9)

Connect the BASE ADAPTER MOTOR with a red long cable to the positive bus, with a brown long cable to the negative bus and with the orange long cable to C28 (D10)

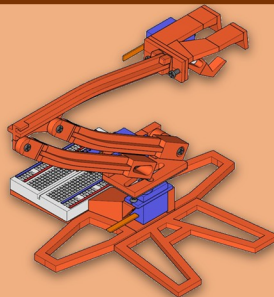
Connect the power supply to the positive bus and the negative bus

Double check all the connections and plug the power supply into the AC socket!

*The flower will start to follow the light!
Check if it prefers the window or a lamp!
If the flower is avoiding the light source try
changing the order of colorful cables
coming out of the flower*

robo ARM

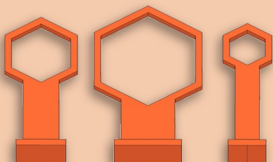
★★★★★



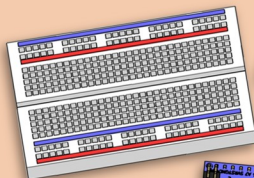
Do you want to have your own robot? Why not? Let's use the skills we learned in the previous examples to build a robotic arm!

PREPARE:

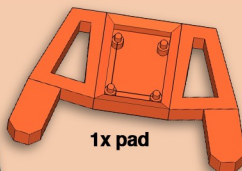
3x training loops



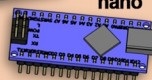
1x breadboard



1x pad



1x Arduino nano



1x joystick



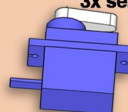
1x power supply



1x USB cable



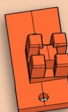
3x servo motor



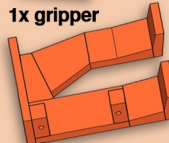
1x claw



1x gripper adapter



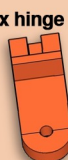
1x gripper



1x double beam



2x hinge



1x unconstrained beam



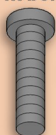
1x constrained beam



3x washer



1x bolt 14mm M3



4x bolt 12mm M3

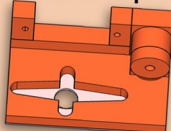


6x bolt 8mm



3x bolt 4mm

1x base adapter



Cables:

1x red short

1x black short

3x orange long

3x red long

3x brown long

MALE-FEMALE CABLES:

- black

- red

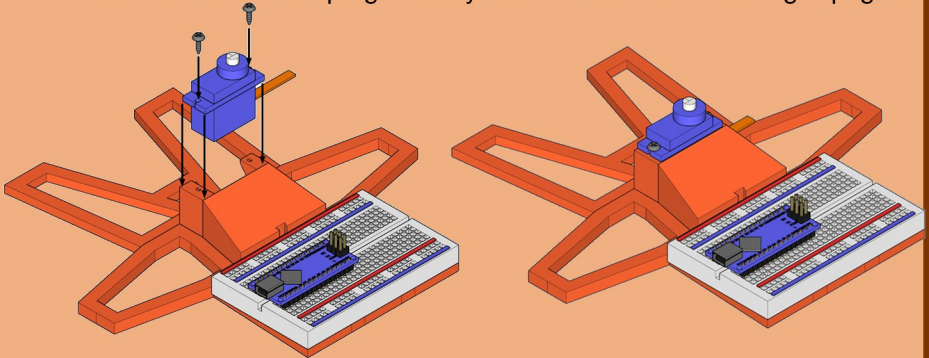
- purple

- blue

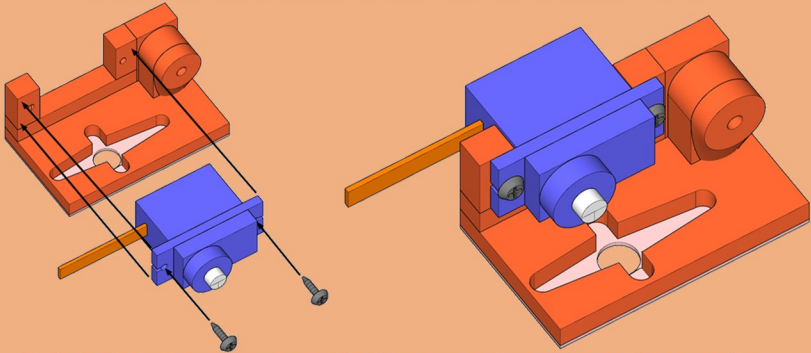
- yellow



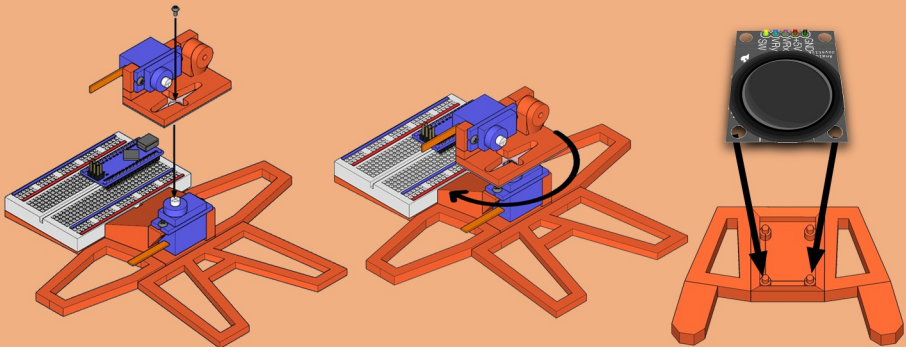
1. Install the RoboarmSBG program on your Arduino board according to page 6



2. Attach the servo motor to the base with two 8mm bolts

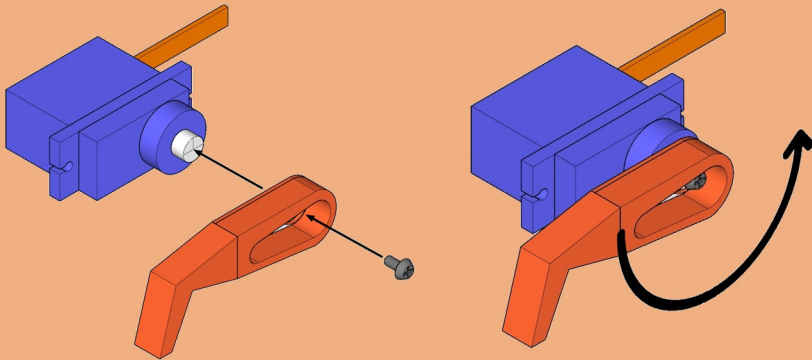


3. Attach the servo motor to the base adapter with two 8mm bolts

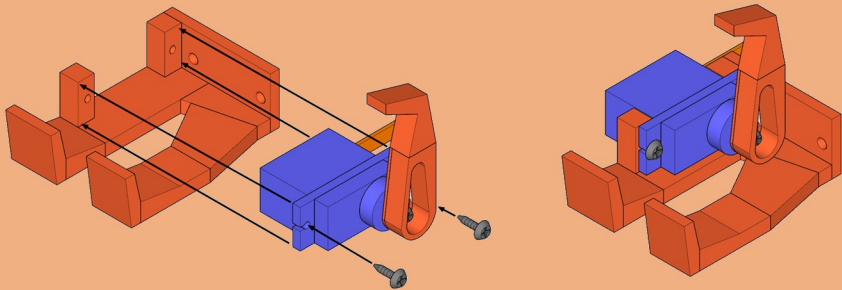


4. Attach the base adapter to the base servo with the m4 bolt. It should be able to make half of a rotation according to the black arrow

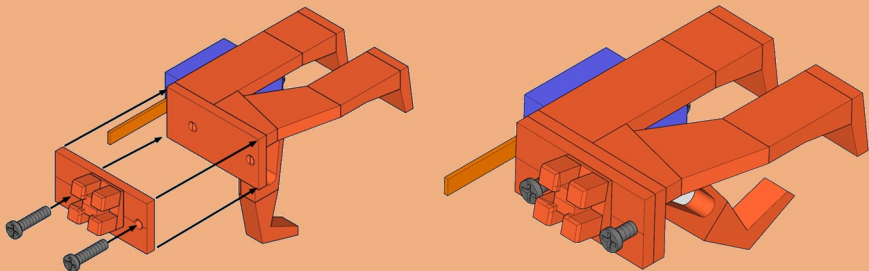
Carefully press the joystick into the pad's attachments. The joystick's pins should point upwards



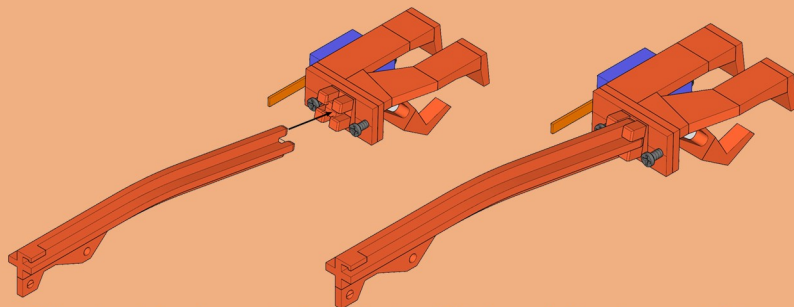
5. Attach the claw to the servo with a 4mm bolt, so that it can make half of a rotation according to the black arrow



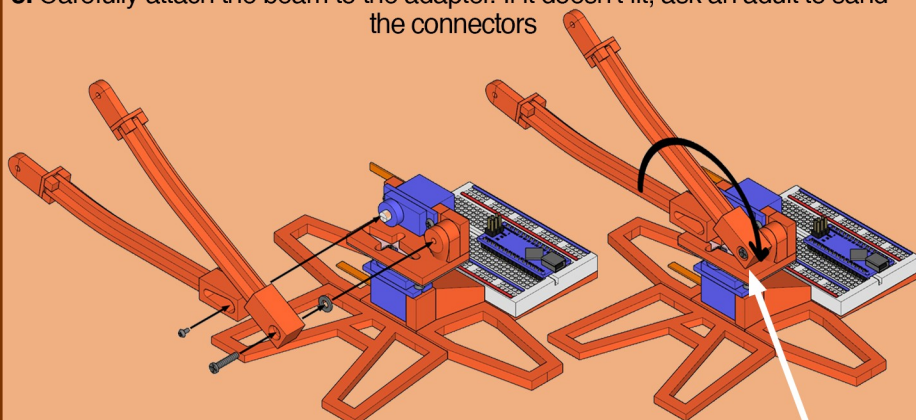
6. Attach the claw servo to the gripper with two 4mm bolts



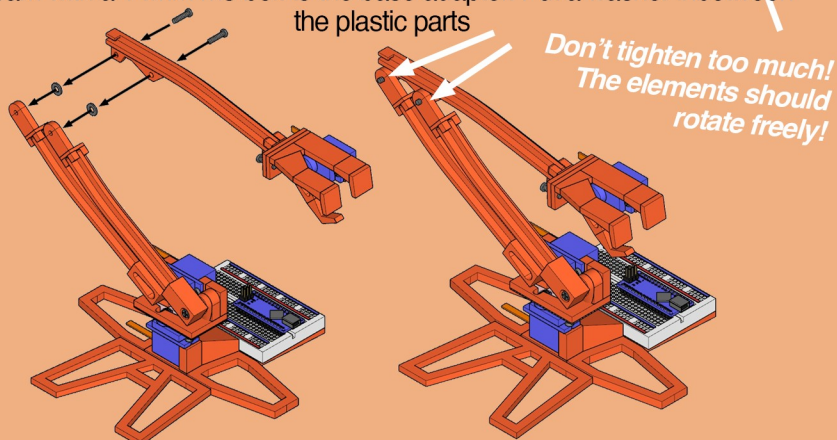
7. Attach the gripper adapter to the gripper with two m3 12mm bolts. Don't screw them all the way in, leave a few mm of space



8. Carefully attach the beam to the adapter. If it doesn't fit, ask an adult to sand the connectors

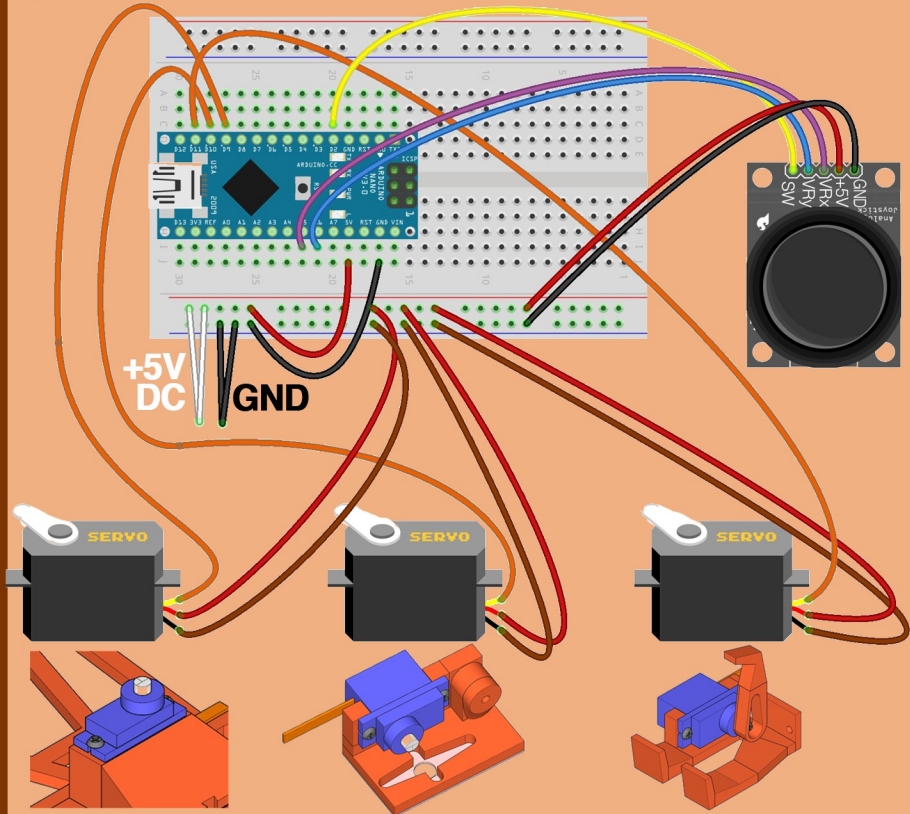


9. Attach the beam to the servo in a way, so that it can make half of a rotation according to the black arrow (4mm bolt). Attach the unconstrained beam with a 14mm m3 bolt to the base adapter. Put a washer inbetween the plastic parts



10. Attach the double beam to the hinges using 12mm m3 bolts. Put washers inbetween the plastic parts.

Electronics:



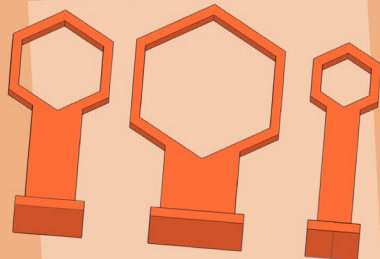
11. Connect the electronics according to the diagram

Connect the power supply

Double check all of the connection and plug the power supply into the AC socket!

You can now steer the robotic arm with the joystick! Pressing the joystick opens the gripper.

Can you catch the training loops and move them into a box? Start with the biggest loop. The smaller they are, the harder it gets!



Congratulations! :D

You are a Robotics Master now!

What now?



***You already know the basics of Arduino** and you have a lot of mechatronic elements! Maybe you can design and build your own robot?*

The possibilities are unlimited - you just need your imagination!

Maybe in your new project you can use your LEGO bricks, carboard, scotch tape, toothpicks, modelling clay?...

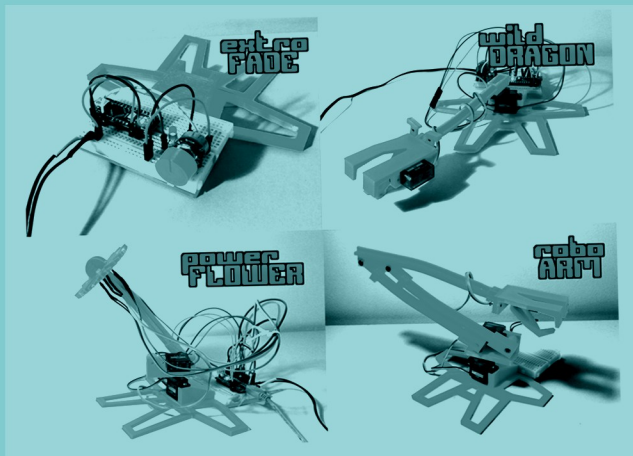
Writing your own programs requires some practice, but I recommend that you start by trying to understand the programs attached to the Super Bot Gears set. Perhaps they can be improved somehow?

If you need help in your Arduino adventures visit the www.arduino.cc website. There you can find many introductory materials, courses and tutorials!

*With best wishes for the future,
the creator of the "Super Bot Gears" set:*

- bzqp

February 2020





bzqp 2020